

2008 CURRENT ISSUE TOPIC

Recreational Impacts on the Natural Environment

Pennsylvania is blessed with a rich diversity of fish, wildlife, and plants. More than 10,000 species of plants and animals are known to exist in the Commonwealth. As inventory efforts continue, it is estimated that the total number of known plants and animals in Pennsylvania will reach 20,000 species. This diversity of species contributes to Pennsylvanians' well being by providing important recreational, economic, and biological benefits to the Commonwealth.

Recreation, whether active or passive, is vitally important to everyone and offers physical, emotional, and spiritual benefits. The amount of time and money people spend on recreation is rising, along with the diversity of recreational opportunities.

Webster's defines recreation as *refreshment in body or mind, as after work, by some form of play, amusement, or relaxation* and includes games, hobbies, sports, and other activities. For our purposes, we will narrow the focus to outdoor activities within a natural setting. Examples for Pennsylvania include hunting, fishing, hiking and backpacking, skiing, mountain biking, rafting and kayaking, bird watching, and cultural observations/explorations. These may be low- or high-tech, low- or high impact, and require little or strenuous physical exertion. No matter the form of recreation, humans are consumers and leave behind some trace upon the earth. This "trace" often grows considerably as the number of people using that resource increases and can negatively impact vital natural resources.

Recreation is important to the economy. Consider these statistics for Pennsylvania. In 2005, the PA Fish & Boat Commission sold more than 825,963 fishing licenses and 580,650 trout/salmon and Lake Erie fishing permits. Fishing has a tremendous impact on Pennsylvania's economy, generating an economic effect of over \$1.65 billion. More than 2.5 million people boat on Pennsylvania waters each year. During 2005, 350,599 boats were registered in Pennsylvania. The Fish & Boat Commission estimates that boating has a total economic impact of \$1.7 billion per year. Hunting is also vital to Pennsylvania's economy, with an economic impact of \$4.8 billion annually, according to the Center for Rural Pennsylvania. Much of that comes from white-tailed deer hunting, which is the favorite pursuit of many of the state's sports enthusiasts. In 2005 alone, the PA Game Commission generated over \$35 million on license fees. Hunting and fishing retail sales generate over \$1 billion each year.

How might recreation impact natural resources? One impact often gives rise to more, creating a cascading effect that may become difficult for land managers to control. Changes in water quality and alteration of surface flows impact water. Compaction and erosion often degrade soils. Non-native flora and fauna can be introduced into the ecosystem, causing shifts in the balance from native to non-native species. The frequency of wildfire can change, causing shifts in the flora and fauna of an area. Recreation leads to an increase in the use of energy, especially fossil fuels, leading to air and water pollution. Noise pollution may alter natural range and habitat especially critical to sensitive species. And, how do we manage human waste that is a by-product of our lifestyle?

These are only a few of the potential impacts. And, all are intertwined. A prime example: as soils are disturbed they may erode with resulting debris creating runoff into nearby streams, thus changing the water quality. The change in water quality may have serious repercussions for native species that rely on cleaner water. Non-native species may out-compete native species if they can tolerate the sediment load while the natives do not. This, of course, is a simplified version of a possible chain of events. In reality, the impacts are far more extensive and complicated.

Some questions to ponder:

- What is your favorite recreational activity? How do you think the activity impacts natural resources? How might you reduce any negative impacts that directly or indirectly result from this pastime?
- What might be the impact of limiting certain recreational activities? Is preservation (no use) better than conservation (managed use)? How can we manage use in order to minimize negative impacts?
- In the face of increasing demand for both traditional and new forms of recreation, how can we balance our need to enjoy the natural world with maintaining the quality of the environment?
- Although recreation can add significantly to both local and state economies, are there options through preservation and conservation to off-set the losses due to decreased recreation?

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Learning Objectives: "Recreational Impacts on the Natural Environment"

GOAL

Students will analyze long term and short term environmental, social, and economic factors relative to recreational impacts upon natural resources and their management.

ACTIVITIES

1. Students will analyze the availability of natural resources and the diversity of biotic communities, focusing upon factors that invite outdoor recreational users.
2. Students will research and identify recreational impacts upon natural resources, focusing upon their environmental implications.
3. Students will examine unique challenges for natural resource managers in Pennsylvania, due to its humidity, potential for drought, and growing human population and focusing on management concerns in the face of increasing recreation. .
4. Students will identify key stakeholders in the business of recreation and tourism, including values and positions each holds toward outdoor recreation and natural resources.
5. Students will describe interconnectedness between socio-economic, technological, and ecological aspects of recreation.

OUTCOME

Students will be able to recommend action relative to a natural resource management challenge that will:

1. Minimize adverse impacts to natural resources.
2. Build consensus among key stakeholders.
3. Accommodate diverse audiences.
4. Contribute positively to the economic impact of a specified geographical region.

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Outcomes and Indicators: "Recreational Impacts on the Natural Environment"

I. Biotic communities and environmental factors

Investigate the biodiversity of Pennsylvania by:

- Identifying, comparing and contrasting the flora, fauna, of the following life zones: forest & woodlands (maple-beech-birch forest, oak-hickory forest, and oak-pine forest); waterways (streams, lakes, rivers), riparian systems, grasslands, and wetlands.
- Analyzing natural ecological factors of each community to determine its suitability for river/aquatic recreation, terrestrial recreation, and aerial recreation.

II. Recreation in Pennsylvania's climate

Analyze the current and potential recreational impacts upon an area by:

- Identifying factors that attract recreation/tourism to an area, including proximity/access to travel, quality of destination site, amenities, suitability for intended purpose, safety.
- Analyzing values and attitudes toward tourism from the perspective of various: stakeholders: local residents, local businesses, local and regional land managers, state agencies, federal agencies.

III. Recreational impacts upon natural resources

Assess known and potential environmental impacts created by recreation by:

- Examining land usage and soil patterns following recreational activity or anticipated to be caused by future activity.
- Analyzing historic and contemporary cultural attitudes toward ecological, social, and technological concerns.
- Examining current and predicted water quality and quantity issues.
- Considering wildlife needs and concerns of wildlife managers.
- Examining relationships between the native and non-native vegetation of an area.
- Evaluating data to estimate and recommend a future management plan for a selected site.

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Resources and Contacts: "Recreational Impacts on the Natural Environment"

Biotic communities and environmental factors

1. Major Natural Resource Issues Facing Pennsylvania
http://www.connectoutdoors.state.pa.us/McKinstry_GovernorsOutdoorNRIssues_lite.pdf
2. Snapshot 2002 Biodiversity in Pennsylvania – **Required pp. 1 – 10, 14 – 20, and 24 – 32**
<http://www.pabiodiversity.org/snapshotweb.pdf>
3. Pennsylvania's Wildlife Action Plan
4.2. Pennsylvania's Valuable Wild Resources
<http://www.pgc.state.pa.us/pgc/cwp/view.asp?a=496&q=164293&pp=12&n=1>

21.1 Location and Condition of Thicket/Shrub land Habitats
<http://www.pgc.state.pa.us/pgc/cwp/view.asp?A=496&Q=166225>
4. Pennsylvania Biodiversity Partnership
What is Biodiversity?
<http://www.pabiodiversity.org/whatisbiodiversity.html>
5. What is an Invasive Plant?
<http://www.dcnr.state.pa.us/forestry/wildplant/invplants.aspx>
6. Invasive Hitchhikers – fact sheets
<http://www.dcnr.state.pa.us/forestry/invasivefactsheets/index.aspx>
 - 6.1 – Hiking
 - 6.2 – Horseback riding
 - 6.3 – ATV riding
 - 6.4 – Biking
 - 6.5 – Birding
 - 6.6 – Boating
 - 6.7 – Fishing
 - 6.8 – Hunting
 - 6.9 – Wildlife Watching
 - 6.10 – Trail Maintenance
 - 6.11 – Camping
 - 6.12 – Leased Campsites
7. Low-Impact Recreational Practices for Wilderness and Backcountry – **Required pp. 1 – 14, FYI pp. 15 - 97**
<http://leopold.wilderness.net/pubs/183.pdf>
8. The State of Canada's Environment - 1996
Chapter 1 – Understanding Connections - Highlights
<http://www.ec.gc.ca/soer-ree/English/SOER/1996report/Doc/1-5-2-2-1.cfm>

A holistic View of People and the Environment – Chap. 1
<http://www.ec.gc.ca/soer-ree/English/SOER/1996report/Doc/1-5-2-5-1.cfm>

Chapter 11 – Human Activities - Highlights
<http://www.ec.gc.ca/soer-ree/English/SOER/1996report/Doc/1-7-4-2-1.cfm>
9. Camping Tips: Advise for Low Impact Campers
http://tntn.essortment.com/campinglowimpa_rhah.htm

10. Minimal Impact Means Bushwalking Softly
<http://parks.tas.gov.au/recreation/planning/softly.pdf>

Recreation in Pennsylvania's Natural Environment

11. DCNR State Forest Resource Management Plan – Recreation
<http://www.dcnr.state.pa.us/FORESTRY/sfrmp/recreation.htm>
12. Protecting the Trails, Environment and Rights of Others
<http://www.dcnr.state.pa.us/forestry/atv/etiquette.aspx>

Recreational impacts upon natural resources

Economic impacts

13. Economic Impacts of Biodiversity - Pennsylvania Biodiversity Partnership
<http://www.pabiodiversity.org/economic.html>

Historic and Cultural impacts

National Park Service (History & Culture, includes cultural features, both historical and prehistoric)

14. Gettysburg National Military Park – Animals, plants, Environmental Factors, and Natural Features & Ecosystems
<http://www.nps.gov/gett/naturescience/index.htm>
15. Delaware Water Gap National Recreation Area
<http://www.nps.gov/dewa/naturescience/index.htm>

Ecological impacts

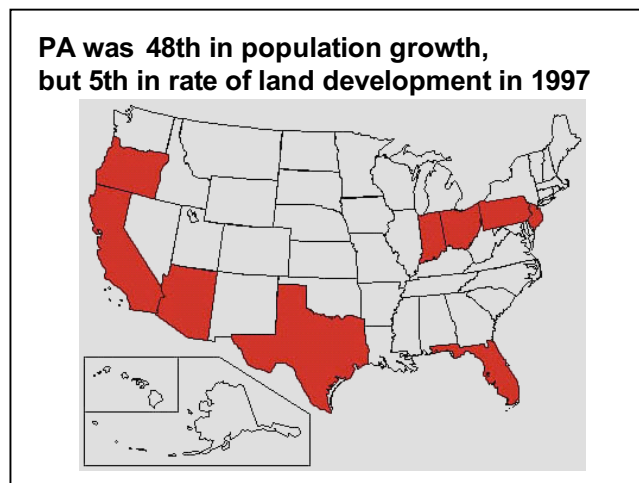
16. Leave No Trace
<http://www.lnt.org/programs/lnt7/index.html> (LNT principals)
17. Wildlife Diversity Program
http://www.pgc.state.pa.us/pgc/lib/pgc/pdf/wildlife_diversity_program.pdf

Major Natural Resource Issues Facing Pennsylvania

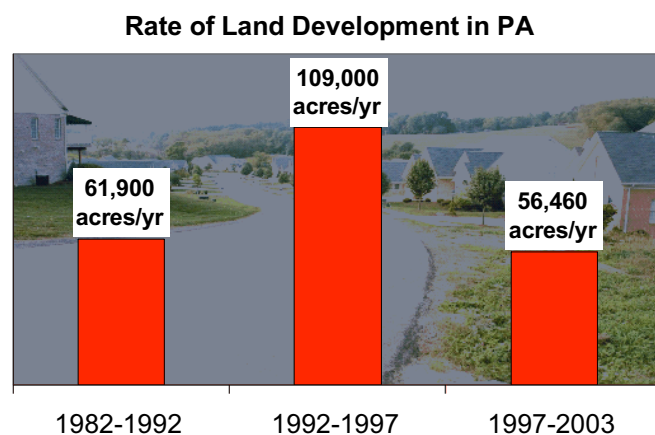
Urbanization in the form of “sprawl” type development, climate change, loss of biodiversity, and impaired water quality represent the major natural resource challenges facing Pennsylvania. These problems often have a significant effect on environmental quality and the state of our natural resources that provide us with the many outdoor recreational opportunities in Pennsylvania. Solutions to these problems may put additional stress on the outdoor environment.

Urbanization and Urban Sprawl

Pennsylvania has one of the highest rates of land development in the U.S., but has had comparably much lower population increases than other top states (Florida, Texas, Arizona, California, etc.). In 1997, PA was 5th in rate of land converted to development, but 48th in population growth. Much of the development in Pennsylvania is low-density sprawl that occurs far outside traditional urban centers, resulting in the loss of prime farmland and forestland, inefficient transportation systems—with commuters traveling longer distances to work, less investment in urban renewal, non-point source pollution, and other negative effects. Poor development and land use practices on urban and residential land degrade water quality and fragments natural habitats and increase greenhouse gas emissions.



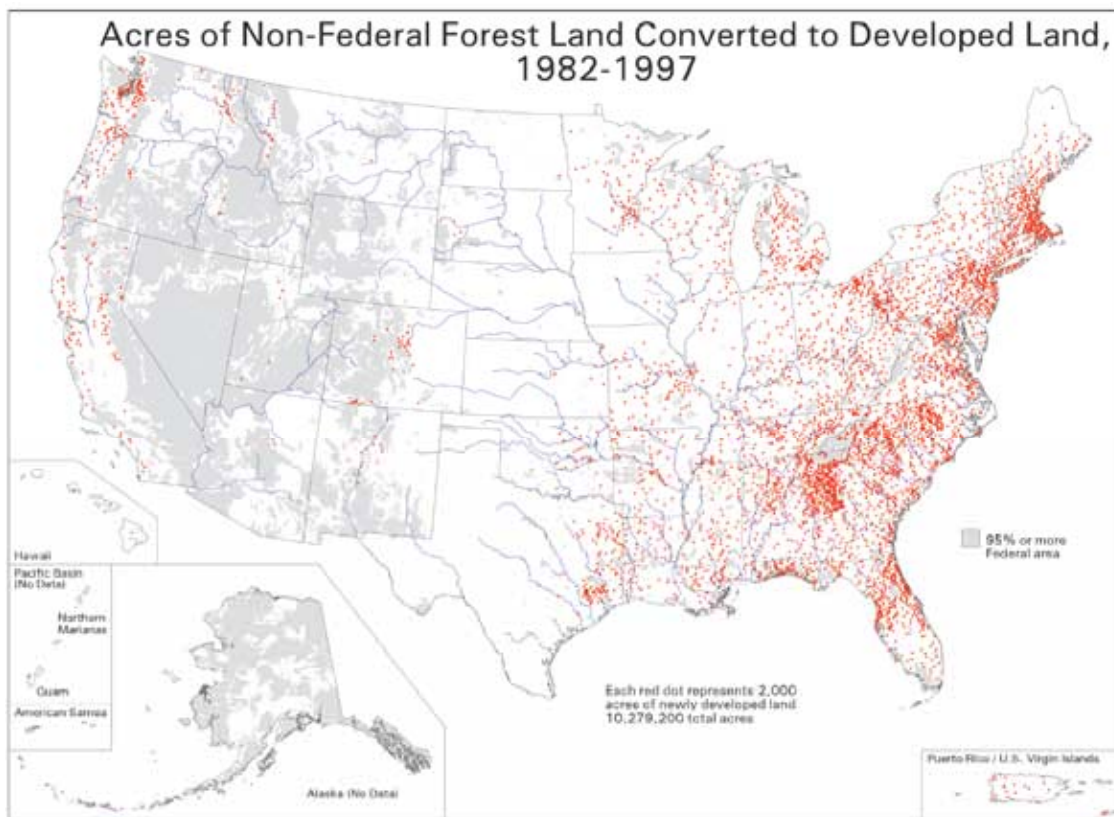
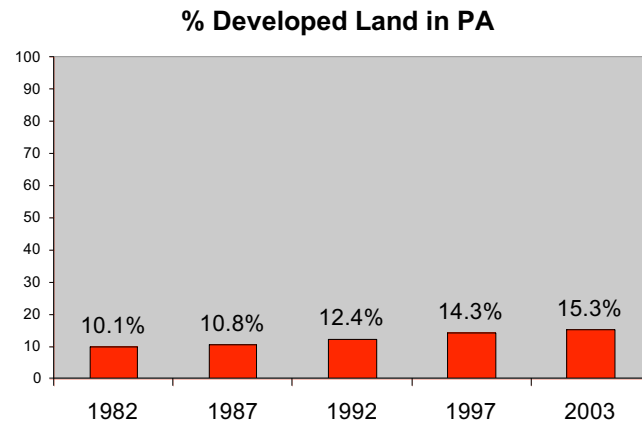
The rate of land conversion to development has slowed somewhat in recent years. Pennsylvania is experiencing land development rates seen in the 1980s, after a peak in 1992-1997. However, development is still spreading out as about 56,000 acres of land per year were converted to



development in the period between 1997 and 2003. Developed land covered about 15.3% of all the land in Pennsylvania in 2003, as compared to 10.1% in 1982—an increase of more than 50%.

The challenge for Pennsylvania is not to prevent further development, but to promote smart growth that mitigates environmental impacts and takes advantage of the benefits of greenspace in development planning.

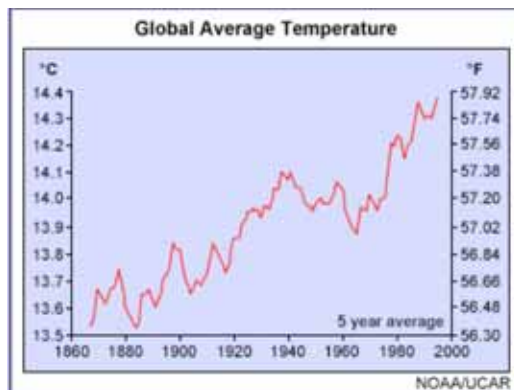
Source: Statistics from NRCS National Resource Inventory,
<http://www.nrcs.usda.gov/TECHNICAL/NRI>



Source: 1997 USDA NRCS National Resource Inventory

Climate Change Impacts: Recreation Shifts and Forest-based Solutions

Climate change is a global issue that has local impacts and will require local solutions. Climate change is likely to create a warmer and wetter Pennsylvania with more extreme and variable weather. Like most of the world, Pennsylvania has already seen an increase in average annual temperature. Climate models predict that the temperatures will increase again by between 4 and 8 ° F by 2050, assuming that no thresholds are encountered that trigger more abrupt climate change.

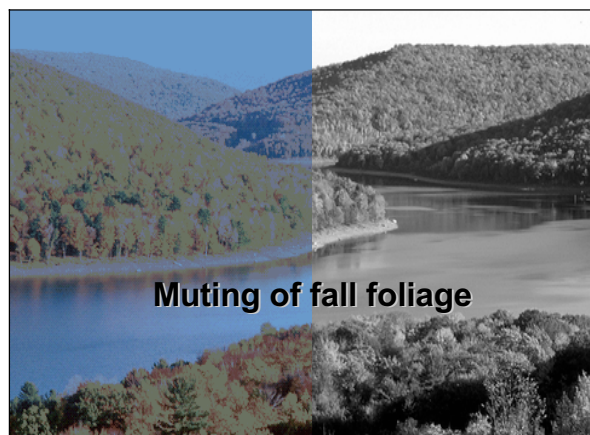
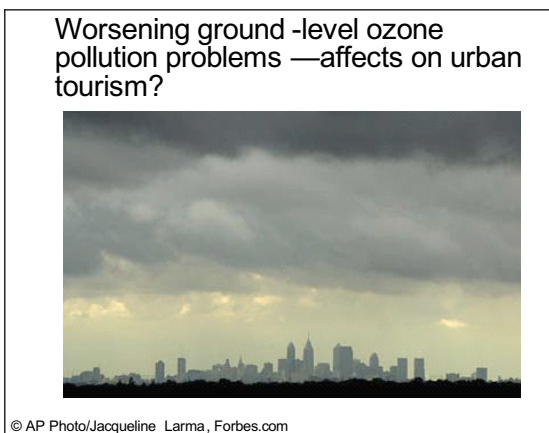


Recreation shifts due to climate change is a major issue for long-term viability of recreational industry. Regional shifts in recreational activity as people make trade-offs in terms of the type, location, and season of their activities. Overall warming and changes in the seasonal characteristics of precipitation are likely to have substantial impacts on recreation in the Northeast, including reduced winter recreation and increased warm season activities.

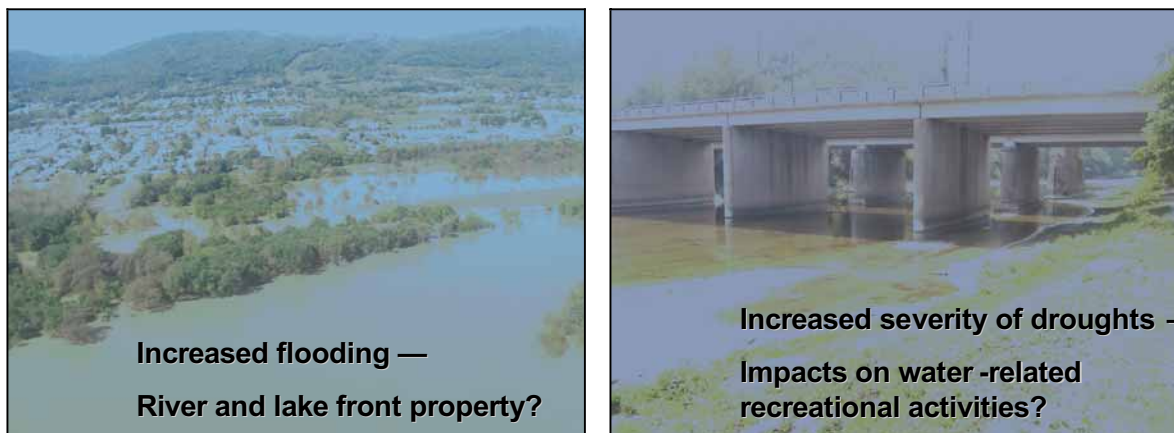
Winter minimum temperatures are likely to warm substantially, as recent winter warm spells have demonstrated. This may result in the inability of ski areas to maintain a winter snow pack and a shortening of the skiing season, but will have a more dramatic impact on opportunities for cross-country skiing and ice-skating on natural water bodies.



The summer heat index is expected to increase. This will likely worsen ground-level ozone pollution problems in urban areas, perhaps detracting from urban tourism. Increased summer heat may increase insect populations. Warming fall temperatures may result in muted fall foliage colors.



Summer recreational activities involving beaches or freshwater reservoirs will have extended seasons and more demand as havens from increasing summer heat. On the other hand, the increased intensity and frequency of floods and droughts may put water-related recreation activities at risk.



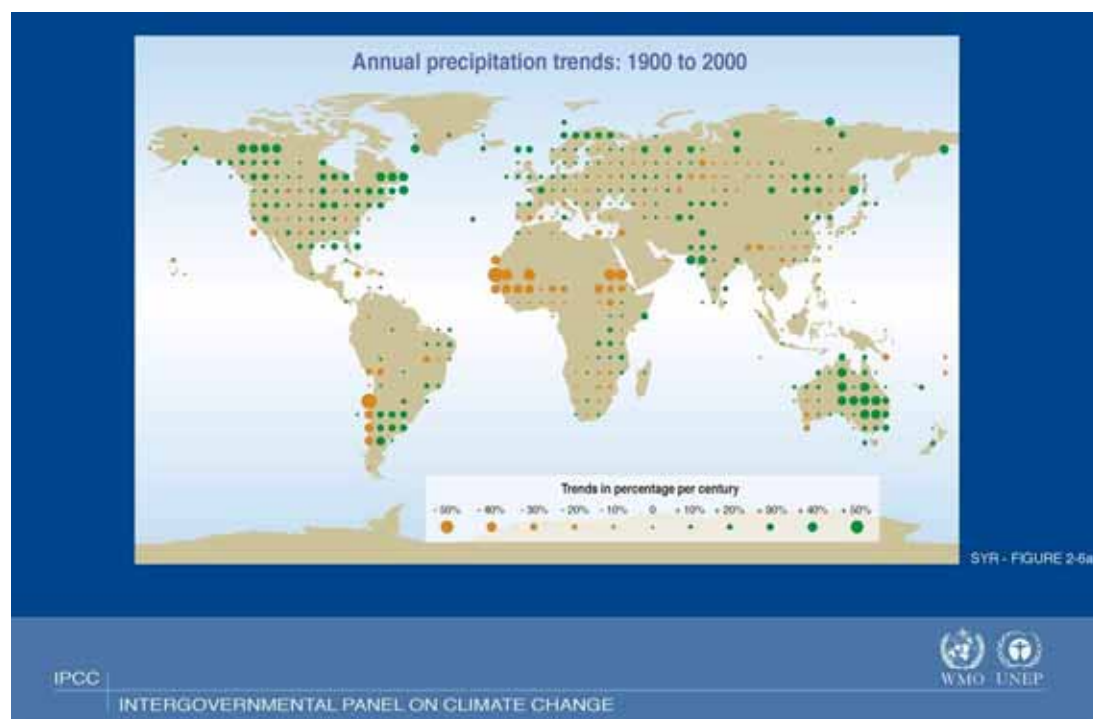
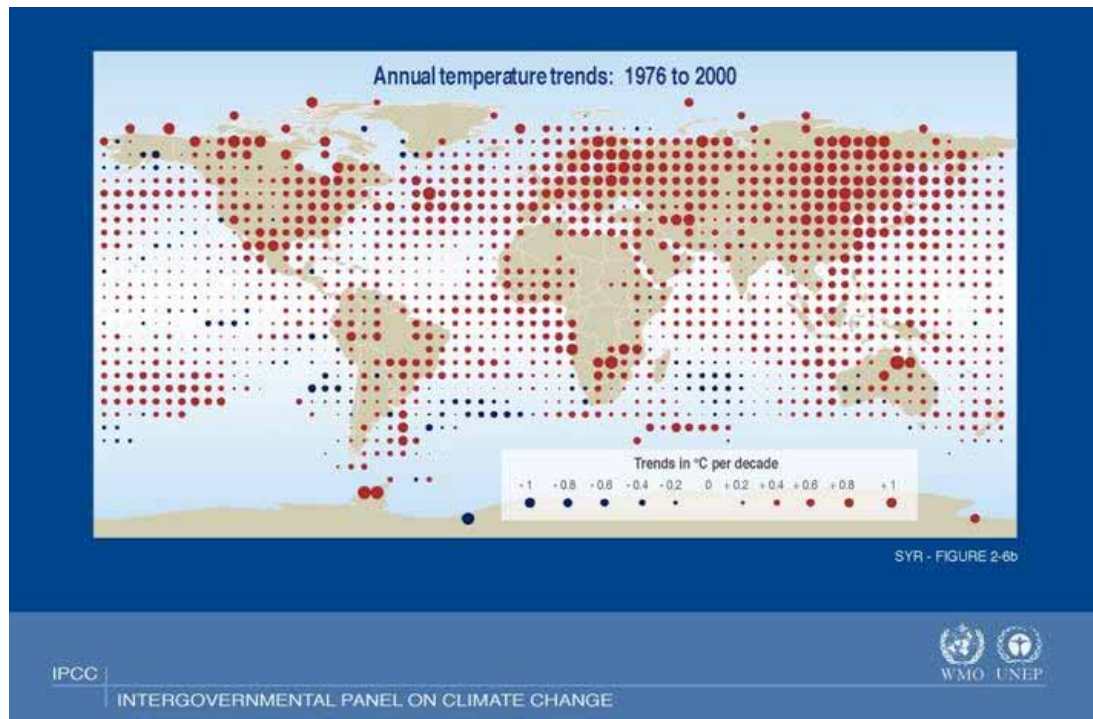
Photos: DEP, North Susquehanna flooding (left) and drought on Conodoguinet River (right)

Climate change is likely to have many consequences for Pennsylvania's forests, indirectly affecting the recreational opportunities that these forests provide. Forest types in Pennsylvania have already begun to shift in many areas, from maple-beech-birch to oak-hickory-pine, resulting in major socioeconomic impacts on the hardwood industry and other forest-based industries in Pennsylvania, such as the reduction in valuable black cherry stock. Climate change presents particular threats to Pennsylvania cold water fisheries, many of which will be converted to warm water fisheries.

Climate change is also likely to affect forest productivity and the frequency of natural disturbances (fire and drought), and to reduce biodiversity. Warm-weather invasive species are expanding their range into Pennsylvania. Change in climate will likely present opportunities for the expansion of invasive species.

The proposed solutions to climate change will also have a significant impact on Pennsylvania's forests. The push for alternative energies will create new demands on Pennsylvania's forests for the production of wood-based energy and as sites for wind turbines on PA public forest lands. The burgeoning carbon credit and trading market has added new value to forests for carbon storage or sequestration. These new interests can be balanced with the continuing use of Pennsylvania's forests for recreational purposes and their biodiversity, but attention must be paid to these issues in planning.

Sources: Intergovernmental Panel on Climate Change, www.ipcc.ch, and *Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change in the Northeast*, National Assessment Synthesis Team, US Global Change Research Program, 2000, <http://www.usgcrp.gov> and <http://epa.gov/climatechange/effects/usregions.html>



From Intergovernmental Panel on Climate Change, www.ipcc.ch

Biodiversity: Maintaining Healthy Ecosystems

Biodiversity is the variety of species, their genetic make-up, and the natural communities in which they occur. It includes all of the native plants and animals in Pennsylvania and the processes that sustain life on Earth (ecosystems). Threats to biodiversity, which helps maintain healthy ecosystems, arise from urbanization and climate change. The major threats to biodiversity in the report of the Pennsylvania Biodiversity Partnership include habitat loss and fragmentation due to urbanization and other consumptive land uses, deer over-browsing, invasive species, and pollution.

Pennsylvania is home to over 25,000 known species of organisms. More than 800 of these are rare, threatened, or endangered, and at least 150 species have been lost from Pennsylvania in recent history. We still do not have a complete inventory of Pennsylvania's plants and animals, although Pennsylvanians consistently place a high value on protecting plants, animals, and their habitats according to survey research.

We depend on valuable ecosystem services, and biodiversity is critical to maintaining ecosystem stability and productivity. Wetland ecosystems filter out toxins, clean the water, and control floods. Forest ecosystems supply fresh water, provide oxygen, control erosion, and remove carbon from the atmosphere.

Biodiversity, by helping maintain healthy ecosystems, plays a major role in the economy of Pennsylvania and, particularly, its outdoor recreation industry:

- The forest products industry in Pennsylvania provides 90,000 jobs in 2,500 firms and contributes more than \$4.5 billion to the economy.
- In 1996, activities associated with watching, feeding, or photographing wildlife generated \$1.8 billion to Pennsylvania's economy, including more than \$236 million contributed by visitors to the state.
- Nearly 20 percent of Pennsylvanians hunt, trap, or fish, spending more than \$1 billion annually in pursuit of these outdoor sports
- Thousands of Pennsylvanians and visitors to our state spend many hours enjoying our natural wonders through hiking, biking, cross-country skiing, and other outdoor recreation.

Source: Adapted from PA Biodiversity Partnership at <http://www.pabiodiversity.org/whatisbiodiversity.html>

Biodiversity is directly linked to recreation, because the over-browsing of deer is one of the most significant impacts on forest regeneration and the establishment of an understory of diverse native species in Pennsylvania—and the primary control on the deer population in Pennsylvania is deer hunting.

The numbers of hunters and so deer kills have a direct relationship to biodiversity, as the Pennsylvania Game Commission has recognized in recent years by partnering with the DCNR to structure their hunting license regulations according to forest management needs throughout the state. As many areas of Pennsylvania have seen declining participation in hunting, the Game Commission may have to help establish programs to increase hunting participation, in order to maintain hunting as a viable mechanism of deer management, or develop new ways to control deer populations in those areas. This is particularly a problem in the southeastern part of the state where hunting has declined and deer populations are putting pressure on increasingly scarce natural areas amid an urbanizing landscape.

Water Quality and Supply

Pennsylvania's streams and lakes provide habitat for aquatic life, as well as an adequate supply of source water for human consumption and provide many recreational opportunities. Pennsylvania has more miles of rural impaired streams than other states. Acid mine drainage has rendered many streams lifeless or nearly lifeless. Many streams are impaired by urban and agricultural runoff. Excess nutrients from Pennsylvania are a significant contributor to environmental degradation in the Chesapeake Bay.

The streams and lakes of Pennsylvania provide unique and precious recreational opportunities for fishing, boating, swimming, and other activities. Especially around urban areas, these resources require intensive management in order to provide for these uses.

Restoration of impaired waters can promote outdoor recreational activities such as swimming, boating and fishing, in a variety of ways. Many of the most impaired streams are those most accessible to urban and suburban populations. Restoration will make water based activities more accessible. Creating vegetated buffers along streams and "daylighting" of urban streams can improve water quality while providing urban populations with access to a natural environment.

Acid Air Pollution

Although great strides have been made in improving the quality of the air in Pennsylvania, air pollution (in addition to emissions of greenhouse gases) remains a major problem that can impair Pennsylvanians' ability to enjoy nature. Many areas of Pennsylvania have failed to achieve compliance with the National Ambient Air Quality Standard for ozone, which can cause asthma, particularly in children. Emissions of mercury and acids from coal-burning power plants and acids from automobiles have had major adverse impacts on streams and forest soils in

Pennsylvania. Nitrate and sulfate emissions from fossil fuels power plants and automobiles cause acid rainfall deposition that acidifies streams, lakes and soils in Pennsylvania. This acidification has stressed native brook trout populations that were already weakened by AMD and urbanization. As a result, acid deposition has impacted cold water fishing opportunities, especially in popular wilderness areas such as in the Pennsylvania Wilds. Acid deposition has also adversely affected forest soils, causing stress and exacerbating problems with regeneration caused by deer over-browsing. Although regulation of acid rain precursors under the 1990 Amendments to the Clean Air Act has improved the quality of rainfall, nitrates still contribute to acidification. Moreover, many coal fired power plants have reduced acidity by switching to low sulfur coal from the West, which is high in mercury, leading to increases in mercury levels in rainfall and, consequently, streams and lakes. Elevated levels of mercury have resulted in fish advisories being issued, recommending limits on consumption of fish from those water bodies. The Pennsylvania Department of Environmental Protection has recently taken action to limit emissions of mercury from Pennsylvania plants, but without more aggressive action by upwind states or an effective federal program, these emissions will continue to adversely affect fishing and health in Pennsylvania.

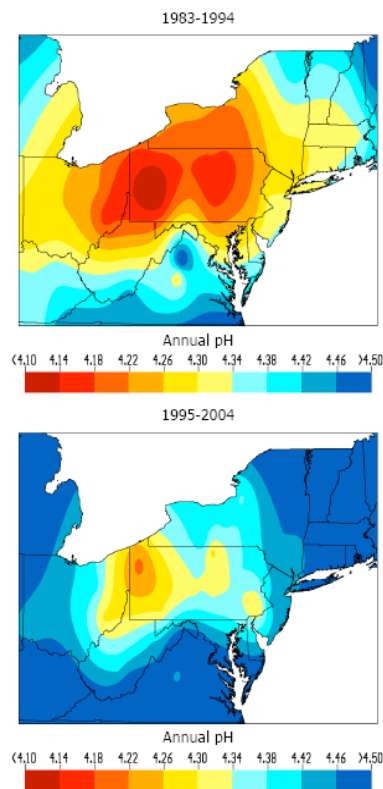


Figure 10. Mean annual pH across Pennsylvania and neighboring states before (1983-1994) and after (1995-2004) implementation of Title IV of the Clean Air Act Amendments of 1990.

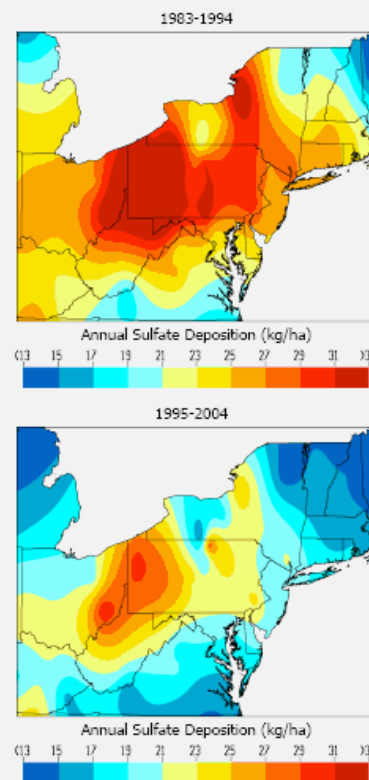
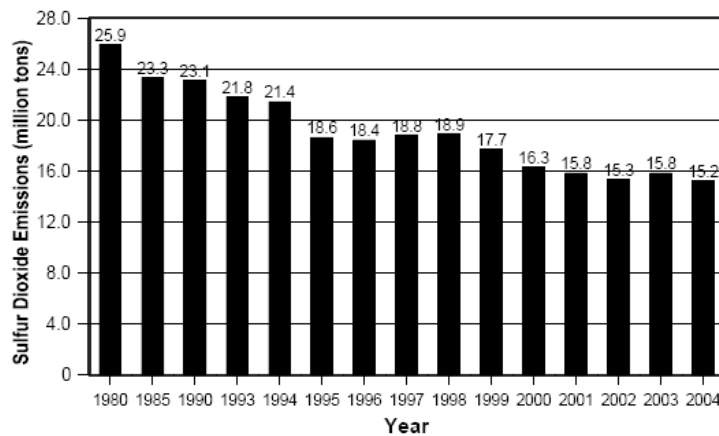


Figure 7. Mean annual sulfate deposition across Pennsylvania and neighboring states before (1983-1994) and after (1995-2004) implementation of Title IV of the Clean Air Act Amendments of 1990.

From Reductions in Acidic Wet Deposition Following Implementation of the Clean Air Act Amendments of 1990 (Sharpe et. al 2006)

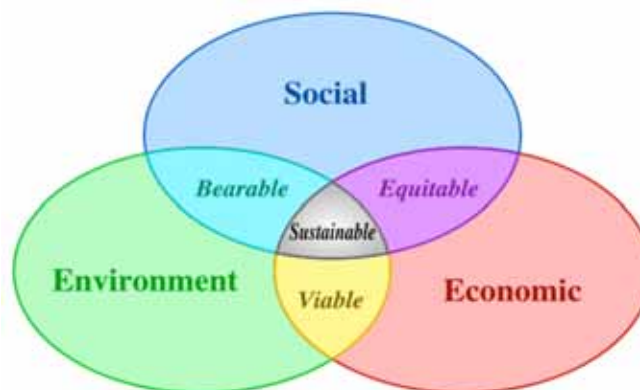


Reductions in sulfur dioxide emissions trend from all point and area sources in the United States (EPA AirData, <http://www.epa.gov/airmarkets/emissions/index.html>) (Lynch et al. 2005).

Solutions

The challenge for environmental management in Pennsylvania is to remedy remedying the degradation caused by past natural resource exploitation and pollution, and to mitigate and manage future risks. To do so, Pennsylvania will need to embrace a culture of sustainable development. Internationally, “sustainable development” has been defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Brundtland 1987). For Pennsylvania, this is not a new concept, being one that was embraced by the Commonwealth’s first Secretary of Environmental Resources, Maurice “Doc” Goddard. Doc recognized that economic development, social well being, and environmental quality were inextricably interrelated.

The model of sustainability, proposed by the United Nations Commission on Sustainable Development, whereby governance balances social, economic, and environmental interests in order to provide equitable, viable, and bearable, *sustainable* development reflects Doc Goddard’s vision:



The importance of the natural environment is exemplified by recent studies establishing the value of various ecosystem services. Most of the natural resources essential to our welfare and economy, such as the provision of clean air and water, the decomposition of our waste, and other “services,” are not valued by traditional economics like the market of human goods and services. While the value of ecosystem services have been calculated as a theoretical exercise for global environment, exceeding trillions of dollars, there are many local studies of ecosystem services and resource valuation that can be used to justify and develop taxes or usage fees based on the cost of maintaining environmental quality for a particular community. For instance, a study of Monongahela River in Pennsylvania found that recreation values are \$6 per trip to keep water quality boatable, \$13 per trip to improve to fishable, and \$51 per trip to improve to swimmable (1997 dollars, travel cost method) (Smith and Desvougues 1986 and Smith et al. 1986 via Wilson and Carpenter 1999). In another example, for the entire United States, Conservation Reserve Program land provides \$443.8 million per year in small-game hunting benefits (Young and Osborn 1990 via Feather et al. 1999), \$175.2 million per year in waterfowl hunting benefits (John 1993 via Feather et al. 1999), \$347 million per year in wildlife viewing benefits (Feather et al. 1999) and \$80 million per year in pheasant hunting benefits (Feather et al. 1999).

Pennsylvania needs to integrate the concept of sustainable development into the management and integration of its state government. It has taken many steps to do so, but more is needed, including the establishment of a sustainability council to integrate programs across state government.

Addressing the challenge of climate change will require the integrated efforts of state, local, federal and international bodies. Many states have developed climate change plans that have involved stakeholders and identified a range of measures that improve their economies while limiting greenhouse gas emissions. Pennsylvania has begun steps in that regard with the Alternative Energy Portfolio Standards Act, DEP’s energy policies, the Governor’s announced energy initiative, DCNR’s carbon management advisory group planning process, the development of a climate road map and Montgomery County’s establishment of a county climate planning process. The state needs to integrate these programs into a statewide planning process.

Addressing sprawl and biodiversity losses requires an integrated state approach. The Pennsylvania Biodiversity Partnership has begun to establish a statewide biodiversity plan. However, it lacks the sanction of state sponsorship and spacially explicit policies that link urban redevelopment with conservation of spaces important to biodiversity. Maryland, Massachusetts, New Jersey and Florida have adopted statewide plans with land use components that can serve as a model for Pennsylvania action.

The state needs to continue and expand its efforts to improve water and air quality. There are a variety of enterprising market based solutions that can assist in this effort. Assuring that those

adversely affecting ecosystems services pay for those effects is an important element of the solution to these problems.

Pennsylvania faces the challenge of preventing the over-usage of resources and to harmonize sometimes conflicting demands. This is particularly the case in the PA Wilds as we encourage development of alternative energy resources and tourism recreational opportunities. The state needs to identify the inevitable conflicts and problems, recognize them and, thereby be able to minimize adverse impacts and maximize the benefits to be achieved.

Source: Hawkins, Katherine. 2003. *Examples of Studies on the Valuation of Recreational Ecosystem Services*. University of Minnesota. Available from www.regionalpartnerships.umn.edu/public/Valuation%20of%20Ecosystems.pdf

Snapshot 2002

BIODIVERSITY IN PENNSYLVANIA



PENNSYLVANIA
BIODIVERSITY
PARTNERSHIP

THE STATE OF BIODIVERSITY IN PENNSYLVANIA IN 2002

Pennsylvania Biodiversity Partnership

The Pennsylvania Biodiversity Partnership is a broad-based, public-private partnership created to promote the conservation of native species and their habitats. PBP is unique in bringing together – as equal partners – organizations and individuals with diverse interests and backgrounds. PBP members represent conservation and environmental organizations, government agencies, business and industry, scientists and academic institutions, sportsmen, and private landowners. For the first time in Pennsylvania, under the leadership of the Pennsylvania Biodiversity Partnership, there is a comprehensive and collaborative effort to address the lack of a statewide biodiversity conservation plan.



Board Members

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Thomas S. Buzby, Hardwood Lumber Manufacturers Association of Pennsylvania
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Snapshot 2002

BIODIVERSITY IN PENNSYLVANIA:

THE STATE OF BIODIVERSITY IN PENNSYLVANIA IN 2002

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PBP Board (see inside front cover)

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Aquatic Management Techniques Used For The Conservation of Biodiversity in Pennsylvania – Jennifer DeCecco and Jay Stauffer, Pennsylvania State University, School of Forest Resources.

Inventory of Biodiversity Databases in Pennsylvania – Dessie Severson, Allegheny Institute of Natural History, University of Pittsburgh, Bradford.

Inventory of the Current State of Scientific Knowledge on Biodiversity in Pennsylvania – Roger Latham, Wallingford, PA.

Methods for the Protection of Land to Preserve Biodiversity – Robert B. McKinstry, Jr. and Michael Jacobson, Pennsylvania State University, School of Forest Resources.

Pennsylvania Law and Policy: Existing Tools to Conserve Pennsylvania's Biodiversity – James M. McElfish, Jr., Environmental Law Institute.

Public Support/Understanding of Biodiversity Issues and Educational Resources for Biodiversity – Joan Clippinger, Pennsylvania Department of Conservation & Natural Resources.

Restoration of Native Species and Habitats in Pennsylvania – Jennifer DeCecco and Jay Stauffer, Pennsylvania State University, School of Forest Resources.

Survey and Conceptual Model of Existing Best Management Practices and Best Stewardship Practices Applicable in Pennsylvania to Promote Biodiversity – Robert B. McKinstry, Jr., Emily B. Schwartz, and Curtis P. Wagner, Pennsylvania State University, School of Forest Resources.

Threats to Pennsylvania's Biodiversity – Jennifer DeCecco and Jay Stauffer, Pennsylvania State University, School of Forest Resources.

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The people have a right to clean air, pure water, and to the preservation of the natural, scenic, historic and esthetic values of the environment. Pennsylvania's public natural resources are the common property of all the people, including generations yet to come. As trustee of these resources, the Commonwealth shall conserve and maintain them for the benefit of all the people.

Pennsylvania Constitution, Article 1, Section 27, adopted in 1971



River otter

About This Report

Pennsylvania's history is richly endowed with our use and enjoyment of its natural resources. The region provided a fertile hunting area for American Indians. Early European settlers marveled at the extensive forests and abundant wildlife found throughout Penn's Woods. In the 1700s, about 25 million acres (more than 80 percent) of Pennsylvania's land were heavily forested with hemlock, pine, beech, chestnut, oak, maple, and other hardwood trees. Travelers to the region noted that passenger pigeons were found in flocks so large they darkened the skies and took days to pass overhead.

Today we find a different Pennsylvania. The needs of more than 12 million Pennsylvanians for food, fuel, medicine, building products, farmland, and living space have had a major impact on the state's biological resources, with mixed results. The passenger pigeon is now extinct. The forests that still occupy about 60 percent of Pennsylvania's landscape are more fragmented and the variety of trees they contain substantially altered. Hundreds of non-native species have intentionally or unwittingly been released into natural ecosystems.

Yet, in 2002, Penn's Woods still embodies a diverse wealth of natural resources that weave an interdependent biological web to form the complex tapestry needed to sustain human life.

Pennsylvania is home to more than 25,000 species of known organisms, and perhaps many thousands more yet to be identified in the state. Over 800 plant and animal species are considered to be rare, threatened, or endangered in Pennsylvania. These resources, if used wisely, can continue to support Pennsylvania's vibrant economy and provide a healthy, valued quality of life. However, many threats to our natural biological diversity are present, ranging from the proliferation of invasive plants to the degradation of ecosystems.

While surveys indicate that many Pennsylvanians easily recognize and support the value of protecting the diversity of animals, plants, and their habitats, biodiversity is not a commonly understood term. In addition, very little is known about many groups of organisms, such as insects, fungi, and algae, including not even knowing what species live in the state.

Animals, plants, and their unique habitats are being lost every year in Pennsylvania due to natural forces, human activities, neglect, and lack of coordination. Recognizing the need for a better understanding of Pennsylvania's rich natural resources as well as the lack of a comprehensive strategy for biodiversity conservation, the Pennsylvania Biodiversity Partnership (PBP) was formed in 2000 in direct response to a recommendation by the Pennsylvania 21st Century Environment Commission.

Biodiversity in Pennsylvania: Snapshot 2002 is a summary of a year-long effort by the Pennsylvania Biodiversity Partnership to identify and consolidate information on the current state of Pennsylvania's biodiversity. This publication represents the first phase of the development of a statewide plan for biodiversity conservation in Pennsylvania, a multi-year process under the leadership of PBP.

Biodiversity in Pennsylvania: Snapshot 2002 summarizes the status of Pennsylvania's biodiversity as we presently know it, including wildlife and their habitats, laws, policies, funding, and educational resources relevant to biodiversity. It is designed to provide a baseline for future comparisons of how well we fulfill our roles as stewards of Pennsylvania's extraordinary natural wealth.

Phase Two will further pinpoint gaps in our knowledge; identify ways to fill those gaps; begin to formulate and consolidate recommendations; and provide a blueprint for how to achieve the final plan. These documents will serve as the focus for regional meetings in both Phase Two and Phase Three with expected completion of the *Pennsylvania Biodiversity Conservation Plan* in 2005.

Biodiversity in Pennsylvania: Snapshot 2002

- Summarizes the current status of Pennsylvania's biodiversity.
- Presents information without making judgments or recommending actions.
- Summarizes reports prepared by scientists, lawyers, and other experts.
- Serves as the base on which to build the Pennsylvania Biodiversity Conservation Plan.

What is Biodiversity?

The air we breathe, the water we drink, and the foods we eat are fundamental to our existence. Supplying these essentials depends on an intricate web of life involving the naturally orchestrated interaction of millions of different animals, plants, fungi, and microscopic organisms. All of these biologically diverse communities of animals and plants provide numerous ecological, economic, and esthetic benefits.

- They give us food, fuel, and medicines.
- They help clean our air, purify our water, break down wastes, and provide flood and pest control.
- They are used as the raw materials for buildings, clothing, furniture, paper, and numerous other products.
- They are a constant source of recreation and enjoyment ranging from hiking, hunting, and fishing to nature study.

ECOSYSTEMS AND THEIR FUNCTIONS

The term ecosystem is defined as a community of living organisms combined with their associated physical environment. It is our “home system” that makes life possible. Ecosystems are the full tapestry of nature that support life and they also provide valuable services.

- Wetland ecosystems filter out toxins, clean the water, and control floods.
- Estuaries act as marine-life nurseries.
- Forest ecosystems supply fresh water, provide oxygen, control erosion, and remove carbon from the atmosphere.

Many species, working together, are needed to provide these critical services. The loss of biodiversity reduces nature's ability to perform these functions. As greater fluctuations occur, ecosystems as a whole become less stable. Instability causes ecosystems to be more vulnerable to extreme conditions and may also decrease productivity.

*Biodiversity
embraces all
living things,
including
humans,
and how their
existence - and
survival - are
interconnected.*



Why is Biodiversity Important?

While the term “biodiversity” may not be well known or understood, the ecological services provided by biodiversity are vital to everyday life. Not a day, hour, or even second goes by that we do not depend on biodiversity for survival.

- The air we breathe is a product of photosynthesis by green plants.
- Insects, worms, bacteria, and other tiny organisms break down wastes and aid in the decomposition of dead plants and animals to enrich soils.
- More than 90 percent of the calories consumed by people worldwide are produced from 80 plant species.
- Almost 30 percent of medicines are developed from plants and animals, and many more are derived from these sources.

Economic Impacts of Biodiversity

Biodiversity has a major impact on the economy of Pennsylvania in the form of revenue and jobs created in the state.

- The forest products industry in Pennsylvania provides 90,000 jobs in 2,500 firms and contributes more than \$4.5 billion to the economy. As an added benefit, wood products are made from renewable resources that are recyclable and biodegradable.
- In 1996, activities associated with watching, feeding, or photographing wildlife generated \$1.8 billion to Pennsylvania's economy, including more than \$236 million contributed by visitors to the state.
- Nearly 20 percent of Pennsylvanians hunt, trap, or fish, spending more than \$1 billion annually in pursuit of these outdoor sports.
- Thousands of Pennsylvanians and visitors to our state spend many hours enjoying our natural wonders through hiking, biking, cross-country skiing, and other outdoor recreation.

Snapshot 2002

BIODIVERSITY IN PENNSYLVANIA:

Biodiversity

Biodiversity is a scientific concept developed to embrace all living things, including humans, and how their existence – and survival – are interconnected. Biodiversity encompasses all living organisms, their genetic makeup, their ecological roles, and their interrelationships in the natural communities where they live. Preserving these biological communities is essential to maintaining our quality of life.

The public consistently places a high value on protecting plants, animals, and their habitats.

Executive Summary

Biodiversity in Pennsylvania: Snapshot 2002 summarizes the status of Pennsylvania's biodiversity as we presently know it, including wildlife and their habitats, laws, policies, funding, and educational resources relevant to biodiversity. It is designed to provide a baseline for future comparisons of how well we fulfill our roles as stewards of Pennsylvania's extraordinary natural wealth. *Snapshot 2002* represents the first phase of the development of a statewide plan for biodiversity conservation in Pennsylvania, a multi-year process being coordinated by the Pennsylvania Biodiversity Partnership.

Phase Two will further pinpoint gaps in our knowledge; identify methods and initiate processes to fill those gaps; begin to formulate and consolidate recommendations; and provide a blueprint for how to achieve the final plan. These reports will serve as the focus for regional meetings in both Phase Two and Phase Three with expected completion of the *Pennsylvania Biodiversity Conservation Plan* in 2005.

Understanding the current status of biodiversity conservation in Pennsylvania is an essential first step in determining where we want to go. To achieve the ultimate goal of a statewide plan for improved biodiversity conservation, it is important to establish a sound baseline as well as a strategy for moving forward. *Snapshot 2002* assesses various aspects of the state of biodiversity in Pennsylvania, including the current knowledge and understanding of the state's biodiversity; known threats; how biodiversity is being managed; and the organizations, laws, policies, and funding in place to protect Pennsylvania's biodiversity.

Current Knowledge and Understanding

Pennsylvania is home to more than 25,000 species of known organisms, and perhaps many thousands more yet to be identified in the state. Although no comprehensive inventory of Pennsylvania's biodiversity exists, we know that:

- Over 150 species of plants and animals have been lost from Pennsylvania and 130 species are considered to be globally endangered, threatened, or rare.
- Animals, plants, and their unique habitats are being lost every year in Pennsylvania due to natural forces, human activities, neglect, and lack of coordination.

Even though Pennsylvania has a long history of documenting biodiversity with records of plants and animals dating back to at least the 1740s, biodiversity information is scattered across many agencies and organizations in various formats that are often incomplete, out-of-date, or inaccessible. Gaps in information at all levels make it difficult to form a comprehensive assessment of current biodiversity conditions and inhibit our ability to determine future needs for biodiversity conservation.

At the same time, public surveys reveal that people consistently place a high value on protecting plants, animals, and their habitats. Although Pennsylvanians strongly support biodiversity conservation, their perceived knowledge about biodiversity, especially the term itself, is not high. This is not surprising since both the concept and the term are relatively new, even to scientists.

This disconnect between the public's lack of understanding of biodiversity and their support for protecting the environment may be attributed, in part, to a lack of educational materials on biodiversity. Although concepts related to biodiversity were reported in many educational programs, the subject was often limited to individual species or habitats rather than interrelationships among species. Explanations of why species have become endangered or threatened, recovery plans, and critical habitat designations were rarely addressed. The inclusion of biodiversity in the recently adopted Pennsylvania Academic Standards for Environment and Ecology may help close this gap. However, it will not help address the lack of educational materials on biodiversity available to adult audiences.

Threats to Biodiversity

Scientists agree that Pennsylvania's biodiversity is in peril for a variety of reasons, some obvious and some subtle. These threats are generally grouped into two major categories: (1) habitat loss and fragmentation and (2) pollution. Sources of these threats include changing land use patterns, an overabundance of white-tailed deer in many areas of the state, and invasive species. Aquatic organisms, such as freshwater mussels, have been especially impacted by pollution.

Although there is little doubt that human impacts have been largely responsible for a decline in biodiversity in the state, there is much that we don't know regarding how our actions affect species and ecosystems in Pennsylvania. Waiting for this information before reversing damaging patterns can also be detrimental. While progress is being made in correcting some threats, such as point-source pollution, others, such as urban sprawl and invasive species, present increasing problems.

Managing Biodiversity

Best Management Practices

Given our dependence on biological resources for survival, mankind has greatly affected natural habitats in Pennsylvania. Best management practices (BMPs) have become widely recognized and accepted as one of the most effective approaches for managing natural resources on both public and private lands. While most best management practices do not specifically target biodiversity, many are applicable to biodiversity conservation. However, biodiversity conservation can be achieved only if the stewards of private lands have the education, tools, and interest to make it happen.

Land Protection

Land protection is one of the most important components of biodiversity conservation efforts. Land protection activities, including land acquisition, regulations, incentives, education, and most importantly, good stewardship by private landowners, are all components of biodiversity conservation. Cohesive land protection strategies and coordination among agencies are essential to achieving the ultimate goal of biodiversity conservation throughout the Commonwealth.

Habitat Restoration and Species Reintroductions

When best management practices and land protection efforts have failed at conserving biodiversity, restoration and reintroduction projects have been somewhat successful in counteracting the loss of species and habitats in Pennsylvania. The serpentine aster, paddlefish, river otter, and elk are among the many species that have begun their resurgence in Pennsylvania as a result of restoration ecology. Restoration and reintroduction projects have taken many forms, ranging from wetland restoration and fire management to replanting native grasslands and translocating animals to their former ranges. Despite the success of some reintroduction efforts, most are costly and many fail.

Since the science of restoration ecology has emerged relatively recently, many questions remain regarding our ability to restore degraded habitats as well as the best methods for translocating species into their former locations. Loss of habitats and species will likely never be fully reversed, but restoration work and reintroduction of species into areas they formerly occupied can mitigate some of the damage. Nevertheless, these efforts will never be adequate substitutes for the conservation of biodiversity.

Biodiversity Organizations, Laws, Policies, and Funding

Organizations

State, federal, county, and local governmental organizations all have a role in managing the lands, waters, and biological resources of Pennsylvania and can have significant impact on biodiversity conservation. Although these multiple government units provide many tools, they sometimes have resulted in a lack of coordination in matters of land use and biodiversity conservation. For instance, responsibility for monitoring plants, birds, mammals, fish, amphibians, reptiles, mussels, and aquatic insects is divided among state agencies; and no state agency has oversight for terrestrial invertebrates – the largest group of organisms in the state.

Laws and Policies

Although some laws protecting the environment existed prior to the 1960s, there was no concerted effort to protect the use of public natural resources in the state. With passage of the Environmental Rights Clause to the Pennsylvania Constitution in 1971, the government's attitude changed to one of

No state agency has oversight for terrestrial invertebrates - the largest group of organisms in the state.



Monarch caterpillar



Despite the importance of biodiversity and the continuing threats to biological communities, Pennsylvania lacks a statewide strategy for biodiversity conservation.

trustee for public natural resources. This amendment also declared that the citizens of Pennsylvania have a right to a healthy environment and guarantees public rights in preservation of natural values in the environment.

Today, Pennsylvania has numerous laws and policies that relate to biodiversity conservation. These include laws that govern public and private actions affecting lands and waters as well as ones specifically addressing conservation and restoration objectives. Other laws and policies address what biological information is collected, how it is organized, how it is made available to public and private decision-makers, and what requirements or incentives exist to ensure its use. Significant opportunities exist under current laws and policies for government agencies, business, and citizens to develop and implement strategies for conserving biodiversity.

Funding for Research and Conservation

Although there are several funding sources for biodiversity research and conservation in Pennsylvania, the amount of money available does not come close to meeting the projected needs. In particular, funding to gather information on basic questions such as what plants and animals live in the state, where they live, and their ability to reproduce and thrive is limited. Lack of such fundamental knowledge about biodiversity in the state hampers efforts at conservation.

Conclusions and Next Steps

Biodiversity in Pennsylvania: Snapshot 2002 reveals that despite extensive knowledge about natural resource conservation in Pennsylvania and many activities focused on conserving wildlife and habitats, there is much we don't know about biodiversity in the state. Many gaps need to be filled.

In the face of this imperfect knowledge, one point is clear – sustainable use of our natural resources is critical for maintaining Pennsylvania's economic health, as well as the quality of life of all Pennsylvanians. Even with extensive technological advances and modern conveniences, our survival still depends on natural resources.

Despite the importance of biodiversity and the continuing threats to biological communities, Pennsylvania lacks a statewide strategy for biodiversity conservation. Critical habitats, plants, and animals are being lost every year in the Commonwealth due to development, neglect, and lack of coordination among interested parties.

This report is intended to serve as a baseline on which to build the *Pennsylvania Biodiversity Conservation Plan* and marks the completion of the first phase of this process. Phase 2 (2002-2003) will provide a blueprint for how to achieve the final plan and Phase 3 (2003-2004) will result in a *Draft Pennsylvania Biodiversity Conservation Plan*, with expected completion of the final plan in 2005. Meetings will be conducted throughout the state during Phases 2 and 3 to solicit input on local and statewide needs for biodiversity. All Pennsylvanians are welcome to participate in this process.



The full reports, on which Biodiversity in Pennsylvania: Snapshot 2002 is based, are available on the Pennsylvania Biodiversity Partnership website at www.pabiodiversity.org.

Plants, Animals, and Their Habitats

Bull frog

A

ssessing Pennsylvania's biodiversity requires an understanding of diversity at three levels – the diversity of species, the variation between individuals within populations (genetic diversity), and the diversity of landscapes in the state. Assessing the quality and quantity of useful information across these three levels is a critical first step in developing meaningful measures for biodiversity conservation.

Facts About Endangered Species

More than 800 species in Pennsylvania are considered to be of conservation concern including plants and animals whose survival status is at risk not only within Pennsylvania, but also beyond our borders.

- Currently, 130 species still living in the state are ranked as globally endangered, threatened, or rare.
- The U.S. Fish and Wildlife Service tracks 17 species in Pennsylvania listed as endangered or threatened under the federal Endangered Species Act.

Many of the most critically endangered species are found in wetlands and other aquatic habitats.

- About half of Pennsylvania's 65 species of freshwater mussels are endangered or gone from Pennsylvania.
- Nearly 30 percent of Pennsylvania fish species are of conservation concern, including 28 listed as endangered.
- Almost 60 percent of endangered and threatened species of vascular plants in Pennsylvania grow in water-dependent habitats.

SPECIES DIVERSITY

Present Species Diversity

We share Pennsylvania with at least 25,000 known native and non-native species. These species can be grouped into seven general categories: vertebrates, invertebrates, vascular plants, nonvascular plants, fungi, and bacteria and other microorganisms.

Species Category	Current Knowledge
Vertebrates Animals with backbones, including mammals, birds, fish, amphibians, and reptiles	<ul style="list-style-type: none"> • Despite their prominence, Pennsylvania's vertebrate species make up only 3 percent of the total number of species in the state. • Discovery of new species is highly unlikely.
Invertebrates Animals without backbones, including earthworms, flatworms, snails, mollusks, nematodes, spiders, ticks, beetles, butterflies, moths, flies, and other insects	<ul style="list-style-type: none"> • Insects and other invertebrates are the most abundant and least known multicellular organisms in Pennsylvania – less than one-half of the species in the state have been documented. • With about 12,000 species documented for Pennsylvania, invertebrates make up almost 50 percent of the total known number of species. • New state records and species new to science are common, especially of terrestrial insects.
Vascular Plants Flowering plants, deciduous and coniferous trees, and ferns and fern allies	<ul style="list-style-type: none"> • Pennsylvania's vascular plant species are fairly well documented. • Even when combined with vertebrates, these two groups comprise only about 17 percent of the animal and plant life of the state. • Discovery of new species is rare.
Nonvascular Plants Mosses, lichens, liverworts, and green algae	<ul style="list-style-type: none"> • Preliminary checklists have been developed for mosses, lichens, liverworts, and hornworts.
Fungi Mushrooms and molds	<ul style="list-style-type: none"> • Very little information helpful to conservation is known.
Bacteria and Other Microorganisms	<ul style="list-style-type: none"> • Almost nothing is known about the natural diversity of this group in Pennsylvania.

Changes in Species Diversity Over Time

The number of species in Pennsylvania is not constant. Over geological time, many species died out and were replaced by new ones, gradually shaping the composition and structure of today's flora and fauna. While human activities, particularly habitat destruction, have led to a reduction in native species diversity, natural forces, such as climate change, also have altered biodiversity in Pennsylvania.

Over the past 860,000 years, there have been eight episodes of global cooling severe enough to cover part of Pennsylvania in ice year-round. The interglacial period that occurred approximately 128,000 to 67,000 years ago is particularly interesting because it was most like the present one, except human influence was absent. Most species now native to the state were probably present, but they lived side-by-side with species long absent. For example, white-tailed deer, elk, and moose shared the Pennsylvania landscape with two extinct deer species, three peccaries, giant horse, two tapirs, black bear-sized beaver, two elephant-sized ground sloths, American mastodon, and woolly mammoth. The predators stalking them included black bear, timber wolf, and mountain lion as well as three other wild dog species, three other bears, two cheetahs, and jaguar.



Human Influence

Gradual change has been the hallmark of biological communities, but the appearance of one new species – humans – approximately 13,000 years ago resulted in abrupt changes in species composition and distribution.

Undiscovered Species in Pennsylvania

It is astonishing how little we know about Pennsylvania biodiversity, especially the insects, fungi, and less showy organisms. Some species have been overlooked because they are small or have lifeways that prevent them from being easily observed. But others, such as the beautiful, but nameless, species of inchworm moth shown here (family Geometridae, genus *Metarranthis*) remain unknown because they are easily confused with other closely related species found in the same habitats. This species was first recognized as distinct from a population just west of Tyrone, but it is now known to be common elsewhere in southwestern Pennsylvania and adjacent West Virginia, and has been found from New England to North Carolina.



New moth species

Event	Impact
13,000 Years Ago Arrival of humans in the New World	<ul style="list-style-type: none"> • More than two dozen species of large mammals, including woolly mammoths, American mastodons, and giant beavers, became extinct within a few centuries of the arrival of humans to the area that became Pennsylvania. • People's use of fire affected biodiversity. Oak-dominated forests and native grasslands most likely are products of large-scale burning by American Indians.
1600s A small group of Swedes set up a colony in present-day Delaware County	<ul style="list-style-type: none"> • Europeans introduced new plants, animals, and microbes. • Forests were cut down and converted to agricultural land. • Natural resources were exploited far more intensively than by previous human occupants.
Mid-1800s Industrialization rapidly accelerated the pace of change	<ul style="list-style-type: none"> • Since the mid-1800s, at least 150 species have been eliminated from Pennsylvania. • Thousands of non-native species have been introduced, including 1,281 plants – more than 37 percent of the current flora – and 152 invertebrates. • Newly introduced species have often had a destructive impact on native organisms and natural ecosystems.
20th Century Human populations continue to expand throughout Pennsylvania	<ul style="list-style-type: none"> • Landscape changes occurred, including urbanization and large-scale mining and agriculture. • Natural fires were suppressed. • Use of natural resources by humans has increased to an all-time high. • Efforts to conserve biodiversity were initiated in the early 1900s and continue to this day.

GENETIC DIVERSITY

Genetic diversity within species consists of inherited variation among individuals in a single population as well as variation between different populations. Genetic diversity is important to maintenance of species. For example, genetic diversity among individuals reduces the chance that a disease will turn into an epidemic, thereby decimating entire populations or species.

Knowledge of genetic diversity can also be a useful tool for managing biodiversity. For example, genetic analysis is one method for understanding breeding systems. Determining how far seeds and pollen are carried and how far adult animals disperse in search of mates are key questions for conservation. Genetics can also be used to assess the consequences of fish and game introductions, transplantations, stocking, and harvest. However, very little is known about the genetic diversity of individual species in Pennsylvania. Only a few genetic studies have been completed, and these have focused mainly on species of conservation concern.

Ecological Communities

Like species, different community types are ranked in terms of conservation status – whether they are rare or endangered – however, no regulations apply to these rankings. The only comprehensive effort to classify all of the state's ecological communities is an unpublished report completed in 1991. Of the 94 community types defined in that report, 50 percent are considered to be imperiled or possibly imperiled in the state, while 23 percent are not of conservation concern.

The major source of information on the distribution of community types in Pennsylvania is the County Natural Areas Inventories, which primarily focus on the best examples of ecological communities in a county. Although they give some information on the occurrence of plants and animals, especially those of conservation concern, they are not intended as comprehensive species inventories. To date, natural areas inventories have been completed for 33 of the 67 counties, with work currently underway or in the planning stages for the remainder.

LANDSCAPE DIVERSITY

Pennsylvania's landscape may be separated into seven major categories – forests, grasslands and open areas, barrens, subterranean, wetlands, aquatic, and disturbed.

Forests, by far, are the largest community type in Pennsylvania. When Europeans first arrived in Pennsylvania, more than 80 percent of the landscape was forested. Large expanses were covered by hemlock, beech, and pine in the northern part of the state and by oak, chestnut, and hickory in the ridges and valleys.

- Pennsylvania still has about 17 million acres of forest, but the age, structure, and composition of these forests have changed since Europeans first settled the state.
- There are fewer hemlock and white pine today.
- Chestnut is gone except in isolated areas.
- Wild black cherry is a major timber tree.
- Little old growth forest remains due to extensive logging in the late 1800s and early 1900s to build the infrastructure of a growing nation.
- Except for a 4,200-acre tract on the Allegheny Plateau, nearly all of the virgin forest is in fragments of less than 250 acres.
- Most of the forest ranges from 80 to 100 years old and is of uniform maturity.

Natural grasslands are rare in Pennsylvania and many in existence at the time of European settlement were the result of vegetation management with fire by American Indians. The only patches of true prairie occur in western Pennsylvania and are extensions of the midwestern prairie. Most open areas today are typically a result of disturbance by man, including revegetated strip mines, old fields, mountain balds, and forest openings.

Barrens comprise about 3 percent of Pennsylvania's land cover. They are represented by sparsely vegetated gravel/rock outcrops and slopes, grasslands, savannas, thickets, and scrub woodlands. Most barrens have shallow, nutrient-poor soils and are located on exposed ridges or slopes where wind conditions and temperatures can become extreme and fire is frequent. Because of these harsh conditions, barrens often contain highly adapted, rare species of plants and animals and, thus, although small in extent, barrens are critical in terms of biodiversity. The serpentine barrens in southeastern Pennsylvania contain the largest number of endangered plant and animal species in the state.

Subterranean areas, such as caves, are often overlooked as a habitat type. Caves, with their unique formations, temperatures, moisture conditions, and air dynamics provide an important, but fragile, habitat for many invertebrates and vertebrates. Some invertebrates in Pennsylvania caves are found nowhere else in the world. Pennsylvania's caves also provide habitat for many bats, including the state and federally endangered Indiana bat and other small mammals such as the eastern woodrat, which is listed as threatened in the state.

Status of County Natural Areas Inventories



Wetlands are transitional areas between upland and open-water habitats and are delineated on the basis of vegetation, hydrology, and soils. Most of Pennsylvania's more than 400,000 acres of wetlands are located in Crawford, Erie, Monroe, Pike, Wayne, Luzerne, and Mercer counties. Wetlands include *marshes* (dominated by herbaceous plants), *swamps* (dominated by trees), and *scrub-shrub wetlands* (dominated by shrubby plants). *Bogs* are a special category of scrub-shrub wetlands. Wetlands provide important habitat for plants and animals, and are home to some of the rarest species in the state, including bog turtles and spreading globe-flower. More than 50 percent of Pennsylvania's original wetlands have been lost or substantially degraded by filling, draining, or conversion to ponds. From 1950 through 1970, 1,200 acres of wetlands were disturbed each year, resulting in the loss of wetland plant and animal species.

Aquatic communities are habitats that continually maintain open water and include *tidal*, *riverine*, and *lake habitats*. These areas provide food and shelter to a diversity of plants and animals.

In Pennsylvania, *tidal wetlands* are limited to the lower Delaware River and its tributaries.

With more than 83,000 miles of streams – second only to Alaska in the number of stream miles – Pennsylvania has abundant *riverine habitats*. Many of these miles, however, have been adversely affected by industrial practices, including more than 3,100 miles impaired by abandoned mine drainage and 3,116 miles by agriculture. Of the almost 53,000 miles of rivers and streams surveyed for biological health, more than 44,000 miles support fish and aquatic uses while approximately 8,000 miles are impaired.

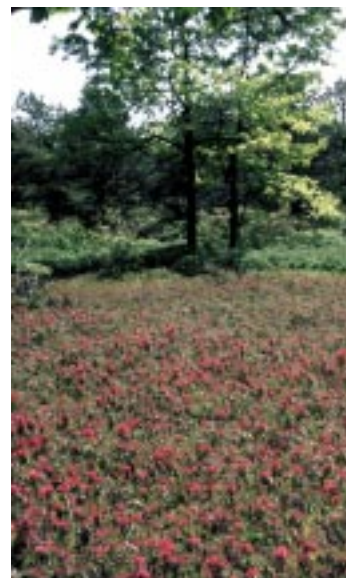
Most of Pennsylvania's *natural lakes* are found in the northwestern and northeastern parts of the state. Of the 65,483 acres of lakes assessed statewide for biological health, 60.1 percent were listed as impaired, with agriculture accounting for most of the damage (13,014 acres). Although often overlooked, small seasonal pools of less than one-half acre play an important role as breeding grounds for many amphibians, insects, and other aquatic invertebrates in the state.

Disturbed communities, which include cultivated land, roadsides, developed land, and backyards, are increasing at a greater rate than any other community type in Pennsylvania. In 1989, there were almost 2 million acres of lawn/turfgrass in Pennsylvania – an area that would cover the states of Delaware and Rhode Island combined. Even though disturbed habitats contain high proportions of alien species, they are important as home to a variety of native species, including woodchucks, deer mice, meadow voles, chipping sparrows, and goldenrods. Although primarily habitats for very common species, these areas can contribute to maintaining wildlife and wild plants in the state. Edges – transition zones where two habitats come together, such as where a forest meets a field – provide a particularly rich diversity of food and shelter for wildlife.

SUMMARY


Gaps in knowledge make it difficult to form a comprehensive assessment of current biodiversity conditions and inhibit our ability to determine future needs for biodiversity conservation. Information is lacking at all levels. No comprehensive inventory of Pennsylvania's plants and animals exists. Information on trends in the abundance and distribution of organisms within the state is meager, and data on genetic diversity are almost completely lacking.

No complete inventory of Pennsylvania's plants and animals exists.



Pocono Tili Barrens

Sources of Information About Biodiversity



Pennsylvania has a long history of documenting biodiversity with records of plants and animals dating back to at least the 1740s. However, this information is spread across many organizations and occurs in a variety of formats, including scientific papers, books, monographs, student research projects, government-sponsored reports, presentations at scientific meetings, unpublished and web-published papers, Christmas Bird Counts, electronic databases, old computer punch cards, species checklists, and even lists of birds visiting home feeders. Compounding the task of compiling all of these data is the realization that useful information does not exist for all species and habitats.

White-lip globe

LOCATING BIODIVERSITY INFORMATION

Information on Pennsylvania's biodiversity is located within government agencies, conservation groups, academic institutions, business and consulting firms, environmental education organizations, nature centers, and with individuals. The most accessible information is contained in published books and field guides, while the ultimate sources of information are the ecological and specimen databases maintained by various organizations and individuals. Even within these sources, there are limitations on the usefulness and accessibility of the information.

Books and Field Guides. Recent books cover the major vertebrate groups and the vascular plants – flowering plants, ferns, and conifers (see Additional Reading in the Appendix). Publications on the more obscure, yet equally important, components of Pennsylvania biodiversity, such as insects and fungi, are lacking. Information on these groups, as well as in-depth information on the more charismatic species, is available only in the scientific literature and other less-accessible sources.

Museum Collections. The ultimate sources of information about Pennsylvania biodiversity are the collections of specimens and associated databases maintained by museums, such as the Carnegie Museum of Natural History in Pittsburgh, the Academy of Natural Sciences in Philadelphia, and other collections. These institutions contain hundreds of thousands of specimens from Pennsylvania annotated with collection dates and locations, and in some cases, habitat information.

This vast data storehouse is potentially an enormously powerful tool for understanding the patterns of biodiversity change over time, but the benefits of this unique resource are far from fully realized. This is partly because much of the information is not in a useful form, often lacking verification of species identification and using obsolete scientific names. Moreover, specimen data are often stored partly or completely in a paper-based format (labels or associated fieldnotes), limiting rapid access and analysis through computers.

Other Ecological and Specimen Databases. A source of ecological data on Pennsylvania biodiversity is the County Natural Areas Inventories, carried out primarily by The Nature Conservancy in eastern Pennsylvania and by the Western Pennsylvania Conservancy in the west. These inventories identify the highest quality natural areas in a county, including maps and descriptions of each site.

In addition to primary specimen and ecological databases, secondary databases, such as the Pennsylvania Natural Diversity Inventory (PNDI), are important sources of biodiversity information. PNDI is a collaborative venture of the Department of Conservation and Natural Resources (DCNR), The Nature Conservancy, and Western Pennsylvania Conservancy. It maintains data on species classified as endangered, threatened, or rare by DCNR, the Pennsylvania Game Commission, the Pennsylvania Fish and Boat Commission, and the U.S. Fish and Wildlife Service as well as data compiled by members of the Pennsylvania Biological Survey to inform rankings for species of conservation concern. PNDI also maintains data on natural community types and geologic features. It does not include data on native species thought to be common.

Additional information relevant to biodiversity may be accessible through Pennsylvania Spatial Data Access (PASDA), a system housed at Pennsylvania State University that makes geographic information systems (GIS) data publicly available for use. While PASDA is not geared to biodiversity, it contains information relevant to decisions that affect biodiversity.

Innumerable and important smaller specimen and ecological data sets have been collected by individual researchers at academic institutions, government agencies, conservation groups, business and consulting firms, environmental education organizations, and nature centers. In many situations, when the researcher leaves the institution, the collection or database is no longer maintained and is “orphaned,” resulting in this information becoming even more inaccessible.

FORMAT AND ACCESSIBILITY

Given that information about Pennsylvania's biodiversity is scattered across many organizations and occurs in a variety of formats, the Pennsylvania Biodiversity Partnership initiated the Pennsylvania Biodiversity Data Inventory (PBDI) to survey the current status of information about the state's biodiversity resources. A request for information was circulated to more than 1,100 individuals and groups throughout Pennsylvania, and also outside the state, asking for a description of any relevant ecological or specimen data they possessed. Even though responses were obtained from some of the major repositories of biodiversity information in the state, the information in PBDI represents just the beginning of a comprehensive inventory.

Most of the larger databases about Pennsylvania biodiversity are either in electronic format or are in the process of being converted to electronic files. However, more than half of these records do not have accurate geographic information associated with them.



Preparing plant specimens

*Information
about
Pennsylvania's
biodiversity is
scattered
across many
organizations.*

Pennsylvania Biodiversity Data Inventory (PBDI)

If you have records of plants and animals you have identified – studied field mice populations in a vacant field for several years; noted the growth of algae in ponds; tracked the species of tadpoles hatching each spring; counted birds in natural areas; or recorded the invasion of purple loosestrife along a stream – please report that you have such information.

The Pennsylvania Biodiversity Partnership has initiated the Pennsylvania Biodiversity Data Inventory (PBDI) to compile information about what biodiversity data exists for Pennsylvania. To add information about your data to PBDI, log on to PBP's website (www.pabiodiversity.org) and follow the instructions for PBDI. Information about data in any format is welcome, from field notes to computer databases!

When searching for biodiversity information, contacts need to be made with many groups, as there is no single source of biodiversity information for Pennsylvania. Most Pennsylvania biodiversity databases are not web-accessible by the public due to a variety of factors including confidentiality of data and intellectual property issues. Fees may or may not be charged and may vary, depending on the individual's institutional association and how the information will be used. PNDI's public-access list contains a rarity ranking for plant communities and plants and animals of conservation concern, but access to site-specific information is restricted to environmental review purposes.

In addition, documentation obtained for different groups of organisms in Pennsylvania varies considerably.

- 22 reports on birds and 33 on vascular plants were received.
- Only one database each on nematodes and bacteria – two of the most numerous organisms in the biosphere – were submitted.
- No databases on earthworms were reported.
- Detailed information on fish and game animals has been gathered, but this covers only a handful of species.
- Much of the state's biodiversity information contains some level of ecological information, but often this is only brief habitat information accompanying specimens.

Although most Pennsylvania biodiversity data is maintained within the state, individuals and organizations outside Pennsylvania, especially museums, also hold information. For example, the Liverpool Museum and the Linnean Herbarium, both in England, have 459 records of plants collected in Pennsylvania between 1740 and 1820.

CLOSING INFORMATION GAPS

Work to remedy data limitations and critical information gaps is underway statewide for a few areas.

- The Pennsylvania Flora Project at the University of Pennsylvania's Morris Arboretum includes information from nearly 400,000 vascular plant specimens in all of the major plant collections in Pennsylvania.
- The Pennsylvania State University Mycological Database includes more than 43,000 fungus specimens collected statewide and held in four major repositories.
- The Pennsylvania Herpetological Atlas is an effort to determine the statewide distribution of amphibians and reptiles.
- The Pennsylvania Aquatic Community Classification Project is developing a standardized aquatic community classification and reference conditions for the state.

SUMMARY

Much of the biodiversity data for Pennsylvania is incomplete or inaccessible. Some collections are accessible, but the information in them is not easily retrievable. Therefore, no comprehensive inventory of Pennsylvania biodiversity information exists.

Given that we don't know the basic fact of how many species occur in Pennsylvania, information on recent trends in their abundance and distribution is meager.

- For nearly all organisms, collections have been geographically biased toward areas near population centers and academic institutions.
- Rare, unusual, and otherwise notable species are over-represented compared with common species.
- Comprehensive surveys of population status exist for only one higher taxonomic group – birds.
- Historical records of statewide species distribution have been compiled for a few groups, but they are based on data gathered over many years and are poorly suited as a baseline.

Gaps in basic knowledge about the state's biological diversity exist. Many of these gaps can be filled by converting existing paper-based information into a digital format and making it available in a standardized format through the Internet. Other gaps can be filled through new analyses of existing information. However, many gaps will require new investigations in Pennsylvania's forests, fields, waters, and wetlands. Those investigations should especially focus on previously overlooked groups of organisms, such as terrestrial insects, as well as collecting information on the ecological context for all organisms and their associations with other species.

Wood thrush

Threats to Biodiversity

Scientists agree that Pennsylvania's biodiversity is in peril for a variety of reasons, some obvious and some subtle. These factors may be grouped into two major categories – **habitat loss and fragmentation** and **pollution**.

Changing Land Use Patterns

- Developed and residential land in the Philadelphia metropolitan area increased by 30 percent from 1970 to 1990. Current projections indicate an increase of another 47 percent from 1990 to 2020.
- Most of this sprawl is derived from increased land use per person rather than increases in population.
- Pennsylvania has lost approximately 25 percent of its farmland to development since 1970.
- More than 500,000 acres of land were developed in Pennsylvania between 1992 and 1997, double the rate for the previous ten years.
- Pennsylvania ranks second in the nation in the amount of open space converted to development.



Habitat Loss and Fragmentation

Perhaps the greatest threat to our biodiversity is the continuing loss and alteration of natural habitats in the state. **Habitat loss and fragmentation** can be caused by a wide range of temporary or permanent landscape changes. While temporary fragmentation can be damaging, permanent habitat loss is the most severe threat to biodiversity. Habitat loss and fragmentation can cause disruptions to biodiversity on many levels, including loss of genetic diversity, loss of species, and loss of remaining suitable habitat.

Pollution

There is a long list of **pollutants** that either affect air or water quality or directly poison organisms.

Non-point source pollution originates from a wide variety of sources, including runoff from farmlands, chemicals from construction projects, herbicides and pesticides from lawns, and acid precipitation. Agriculture and abandoned mines currently are the two largest contributors to non-point source pollution in Pennsylvania.

Point source pollution comes from a discrete source, such as sewage treatment plants and industrial plants. Programs to control the amount of point source pollution entering waterways have been more successful than non-point source pollution programs. In 2000, 43 million pounds of pollution were put into Pennsylvania's waterways compared with 49 million pounds in 1999.

SOURCES OF THREATS

The threats to biodiversity in Pennsylvania have many sources, including:

- | | |
|------------------------------|----------------------|
| • Changing land use patterns | • Climate change |
| • Deer over-abundance | • Mining techniques |
| • Invasive species | • Acid precipitation |
| • Agricultural practices | • Fire suppression |

Changing land use patterns lead to habitat and biodiversity loss as need for additional space for homes, schools, and businesses increases. Although Pennsylvania has not seen the same overall increases in population as other parts of the country, regions of the state, especially southeastern Pennsylvania, have been impacted adversely by urban sprawl and changing land use patterns.

This increasing need for space has resulted in a loss of farmland and open space, thereby decreasing land available to all species. Furthermore, despite efforts to reduce stormwater runoff by retaining vegetation along streams and creating detention ponds, the increase in impervious surfaces, such as parking lots and rooftops, overwhelms the ability of those buffers to control non-point sources of pollution. Surprisingly, few studies document the biodiversity effects of urban sprawl.

Deer represent a major threat to biodiversity because of their present over-abundance in many areas of the state. Deer were nearly extirpated in Pennsylvania in the 19th century due to overhunting. Establishment of more favorable habitat as forests were logged and fields cleared, enforcement of strict hunting regulations, and elimination of predators resulted in an increase in the population to an estimated 1.5 million today. Their increasing numbers and broad dietary preferences have reduced forest understory plants and retarded forest regeneration. Their feeding preferences also lead to secondary impacts. For example, deer find hay-scented fern unpalatable. In areas of high deer density, hay-scented fern dominates the forest floor vegetation, forming a nearly impenetrable layer that chokes out other herbs as well as young shrubs and tree seedlings.

Invasive species are a large and growing threat to native biodiversity. Although native species, such as the elm spanworm and forest tent caterpillar, can become invasive, the greatest threats are from exotic plants and animals. While the introduction of non-native species into Pennsylvania began in the 1600s, the speed and frequency of modern travel has drastically increased opportunities for plants and animals to enter the state from other areas of the world. Most introduced species cause few problems, but others, such as the zebra mussel and gypsy moth, can cause extensive damage to both native species and ecosystems. The threats posed by invasive species include displacement of native species, hybridization, and introduction of pathogens.

The problem of introduced and invasive species is especially prevalent in plant communities. More than 37 percent of the plant species currently found in Pennsylvania did not occur here at the time of European settlement. This includes several invasive plants, such as purple loosestrife, Japanese honeysuckle, garlic mustard, Japanese knotweed, and autumn olive. Many of these, such as autumn olive, were planted as wildlife food and cover, and others, such as Japanese honeysuckle, were introduced as ornamentals.

Agriculture is Pennsylvania's primary industry and approximately one quarter of our land is farmland. Although important to our economy, working farms pose threats to biodiversity, primarily in the form of non-point source pollution from manures, fertilizers, and pesticides. Livestock allowed to enter areas near streams disrupt streambanks, thus increasing erosion and sedimentation. Loss of streamside vegetation removed for crops or livestock also degrades stream systems by destabilizing banks and increasing water temperatures. Despite the potential threats from traditional agriculture, there is also concern over the loss of farmland and other open spaces to increasing development.

Climate change has the potential to affect Pennsylvania's biodiversity, but there is little information on the specific impact on the state's biodiversity. Suggested changes in the mid-Atlantic region include a rise in sea level with damage to coastal zones; less abundant trout and other cold-water fishes; increases in invasive species that thrive in warmer and wetter climates; and replacement of maple, beech, and birch forests by oak, hickory, and pine forests.

Mining of coal and other minerals has occurred in Pennsylvania since the 18th century and has been a major contributor to the state's economic growth. At the same time, this industry has had a major negative impact on water quality, affecting more than 3,100 miles of streams. Many abandoned coal mines still leach a variety of chemicals. Aside from the direct impact of abandoned mine drainage (AMD), mining has further degraded stream channels by causing them to lose flow in areas where bedrock is broken. The loss of sport fishing due to AMD is estimated at \$67 million per year.

In addition, there are approximately 250,000 acres of unreclaimed mine lands, refuse banks, and old mine shafts in 45 of Pennsylvania's 67 counties. Because they are infertile, drought-prone, and subject to extreme temperatures, abandoned mine lands support sparse, unproductive ecosystems with a low diversity of plants and animals. An estimated \$5 billion or more will be required to correct the problems of abandoned mines.

Acid precipitation, or "acid rain," resulting from release of sulfur and nitrogen dioxides during the burning of fossil fuels, automobile exhaust, and other industrial processes, can occur as either wet (rain, snow, fog, or ice) or dry deposition. Progress is being made in this area. Although deposits were slightly more acidic in 2000 than in 1999, statistically significant trends of decreasing acidity are evident at all monitoring sites within the state from 1983 to 2000.

Fire suppression has played a critical role in reducing the size of some specific habitats in Pennsylvania. For example, serpentine barrens, found only in small areas of southeastern Pennsylvania, depend on fire to maintain their unique plant and animal communities. Likewise, pitch-pine scrublands in mountainous regions of northern and central Pennsylvania depend on fire for regeneration. The oak- and chestnut-dominated forests, which covered about half of Pennsylvania at the time of European settlement, and still a major component of forests in the state, owe their existence to repeated past fires.

THREATS TO SPECIFIC GROUPS OF ORGANISMS

Aquatic Invertebrates. Freshwater mussels, many of which were once abundant in Pennsylvania streams, are among the most endangered species in the state. Seven species are listed as endangered under the federal Endangered Species Act. Of the 65 species native to Pennsylvania, at least 12 have been eliminated and an additional 19 should be classified as endangered. Loss of viable riverine habitats due to sedimentation from poor agricultural practices, abandoned mine drainage, and urban runoff were the primary cause of decline of mussel populations. Additional factors such as damming, channelization, loss of host fish species, and more recently, the zebra mussel, have contributed further to population loss.

Many aquatic insects are sensitive to acidified streamwater and other forms of pollution. Studies in the Laurel Hill area in southwestern Pennsylvania documented the reduction or elimination of several species due to stream conditions. While decreases in native streamside plants can impact aquatic species, little information is available on how increasing numbers of exotic plants, such as Japanese knotweed, affect water quality and thus may influence these organisms.

Terrestrial Invertebrates. Invertebrate populations may become increasingly isolated due to fragmentation and habitat loss. Although the effects on forest ecosystems of some non-native insects, such as gypsy moths, are well documented, there is virtually no information on the effects of these species on other terrestrial invertebrates. For example, a variety of biological agents and other insecticides used to control gypsy moth may also destroy non-target species of moths and butterflies. At least



Slag pile



Japanese honeysuckle

Gypsy moth females and eggs



one endangered species (although no longer found in Pennsylvania), the Karner blue butterfly, is susceptible to gypsy moth control methods.

Compounding the threats from habitat loss is the fact that so little is known about terrestrial invertebrates in Pennsylvania. Probably fewer than 50 percent of the species in the state have been documented, and the conservation status is uncertain for those species known to occur here. No Pennsylvania government agency has legal responsibility for terrestrial invertebrates, and thus inventory and management of this largely unknown group of organisms is not a priority for any state agency.

Fish. Introduction of non-native fish, either for sport fishing or accidentally, has altered the aquatic communities of Pennsylvania. In the Mid-Atlantic Highlands Small Streams Assessment, 44 percent of the streams surveyed in the state had non-native fish species. In the Schuylkill River drainage, the primary fish in the main river are all introduced and many of these species are now also in the smaller streams.

High acidity levels in streams also affect aquatic species. The loss of brook trout in tributaries of the upper West Branch of the Susquehanna is attributed to toxicity from abandoned mine drainage. Most urbanized areas in the state contain only pollutant tolerant fish.

Dams fragment habitat by preventing fish migration, and are one of the primary reasons for declines in paddlefish in the Ohio River drainage and American shad in eastern Pennsylvania. The removal of smaller dams along the Susquehanna River and its tributaries, as well as the successful implementation of fish ladders on larger dams, have assisted the return of American shad.

Reptiles and Amphibians. Currently nine species of reptiles and amphibians are listed as threatened or endangered, including the rough green snake, bog turtle, and eastern mud salamander. Loss or alteration of wetlands is the cause of decline for many species, although for some, such as the bog turtle, collecting has also contributed to their population loss.

During the last decade, a significant number of amphibian limb abnormalities have been reported across the country. Although the northern leopard frog is most commonly reported as having deformities, other species are also affected. In Pennsylvania, frogs or newts with deformities have been reported in four counties. The causes are not completely known, but possible factors include increases in ultraviolet radiation, use of pesticides and other toxins, and flatworm infections brought on by other causes.

Acid precipitation impairs the reproduction and viability of some salamanders in Pennsylvania. For the Jefferson salamander, acidic conditions may be the major factor responsible for lack of successful reproduction in the state. Although there is less information on how frogs and toads respond to acid precipitation, wood frogs are generally more tolerant while Fowler's toads show significantly slower growth in, or are absent from, the most acidic ponds.

Collecting and hunting play a role in the decline of some amphibians and reptiles, but there is disagreement if these activities contribute to the decline of box turtles. While some groups consider collecting a major threat, the Pennsylvania Fish and Boat Commission regards urban sprawl and other development as more serious.

There are many reasons for declines in timber rattlesnakes in Pennsylvania, including habitat loss. Despite these declines, limited hunting is allowed for six weeks per year and eight to ten organized snake hunts occur annually. Hunting is not permitted for the endangered eastern massasauga rattlesnake, but other factors, such as urbanization, gravel and coal mining, and highway construction, have contributed to its decline.

Birds. Changes in diversity and population numbers are more closely monitored for birds than for any other organism in the state. National programs, such as the Christmas Bird Count, as well as state programs, including the Breeding Bird Atlas, benefit from the help of many amateur bird watchers.

Currently, 16 species are threatened or endangered in Pennsylvania. Although some of these were never common, many are dependent on aquatic habitats, the loss of which has contributed to their decline. The American bittern, king rail, and least bittern are found only in wetlands. Others, such as the yellow-crowned night heron and great egret, also suffer from loss of water-related habitats.

Habitat fragmentation and loss, especially a decline in interior forest habitat, has had a major impact on birds. In addition, the secondary effects of increased predation of nests and cowbird parasitism have played a role. Loss of open fields, shrublands, and early-growth forests has caused declines in birds associated with these habitats, primarily various species of sparrows.

Two introduced species, house sparrow and European starling, are both cavity nesters and compete with native species for nesting sites. Nest competition partially contributed to the decline of species

such as the eastern bluebird during the last century, although efforts to provide additional cavities have been largely successful.

Various contaminants may have contributed to the decline of raptor species such as Cooper's hawk. Contaminants were present in high, but sub-lethal, levels in the possibly declining sharp-shinned hawks on Kittatinny Ridge in eastern Pennsylvania.

Mammals. Many of the remaining large mammals in the state such as white-tailed deer and black bear are at historically high levels. Both mountain lions and timber wolves were intentionally eliminated from the state, although there are still unconfirmed reports of mountain lions. Beavers have staged an impressive comeback after being hunted to near extinction in the late 1800s.

There are currently six species of small mammals on the threatened and endangered list for Pennsylvania – Delmarva fox squirrel, Indiana bat, small-footed myotis, least shrew, West Virginia water shrew, and eastern woodrat. Many of these species require special habitats, the loss or degradation of which has contributed to their decline. Species of mammals with larger home ranges are also affected by habitat loss and fragmentation.

Fungi. Neither the total number of species of fungi in the state nor their abundance is known, and thus threats to these organisms are difficult to determine. Habitat loss is probably the biggest threat to fungi, although pollutants can affect the diversity of both fungi and bacteria.

Plants and Forests. Threats to the flora include habitat loss, deer over-browsing, and invasive species. For some endangered and threatened species, especially orchids such as showy lady's slipper, collecting by hobbyists has contributed to their decline. Ginseng populations in many areas have been nearly decimated by collecting for the herbal market.

The over-abundance of white-tailed deer is a major threat to plants. High densities of hay-scented fern and New York fern, which deer do not eat, in the forest understory are correlated with the loss of herbaceous species. In areas where deer fencing has been erected or deer density reduced, plants may return, although some species never repopulate. Deer also prevent the regeneration of some forest plants and trees, and therefore are changing the composition of Pennsylvania's forests.

Although invasive plants thrive in disturbed habitats, they also occur in otherwise pristine habitats. Both these and introduced insect pests impact the plants and forests of Pennsylvania. Insects targeted for control include gypsy moths and woolly adelgids, a significant pest of Pennsylvania's state tree, the eastern hemlock.

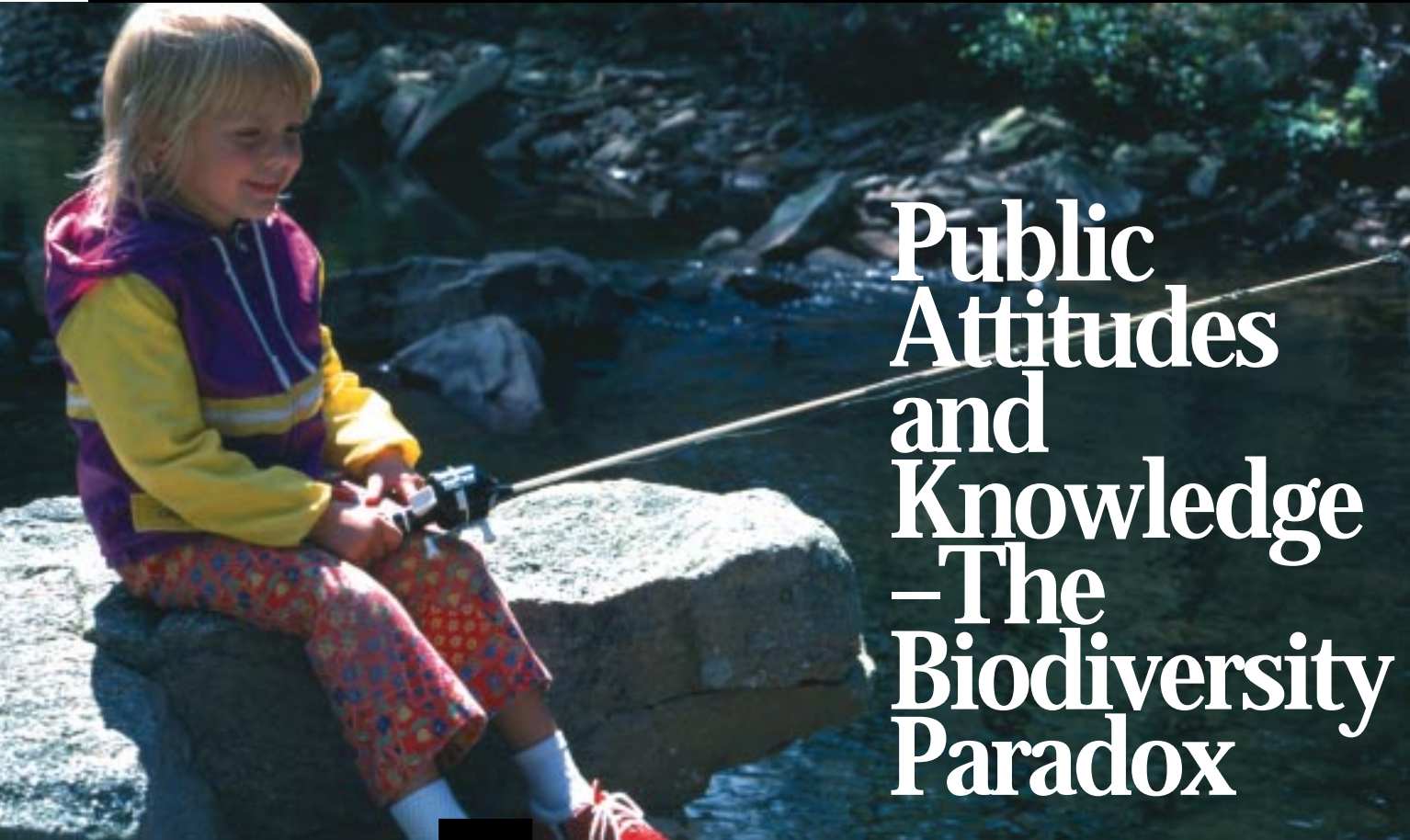
The major threat to mosses and lichens is air pollution, including acid deposition, and the loss of these plants can be used as an indicator of declining air quality.

SUMMARY

Although there is little doubt that human impacts have been largely responsible for a decline in biodiversity in the state, there is much that we don't know regarding how our actions affect species and ecosystems in Pennsylvania. Waiting for this information before reversing damaging patterns can also be detrimental. While progress is being made in correcting some threats, such as point-source pollution, others, such as urban sprawl and invasive species, present increasing problems.



White-tailed deer



Public Attitudes and Knowledge – The Biodiversity Paradox

Public surveys reveal that people consistently place a high value on protecting plants, animals, and their habitats. Although Pennsylvanians strongly support biodiversity conservation, their perceived knowledge about biodiversity, especially the term itself, is not high. This is not surprising since both the concept and the term are relatively new, even to scientists.

- In the 1999 survey for the First Pennsylvania Environmental Readiness for the 21st Century Survey Report, Pennsylvanians ranked green space (91 percent) second only to personal safety (98 percent) as a priority in selecting a place to live. Most residents (64 percent) believed protecting the environment goes hand-in-hand with economic development. When asked to choose between environment and economy, they rated the value of protecting the environment higher by a two-to-one margin.
- Surveys conducted in 2000 for the Pennsylvania Greenways Plan revealed that 93 percent of the people interviewed support the creation of additional greenways. More significantly, protection of natural resources and providing habitat for wildlife were ranked as the two most important functions of greenways. Open space protection and non-motorized recreation activities, two functions often associated with greenways, were less important to the public than the biodiversity value of these areas.
- A 1996 survey by the Pennsylvania Game Commission and the Pennsylvania Fish and Boat Commission reported that 94 percent of the respondents viewed managing and conserving endangered species as important functions for these two agencies.
- 82 percent of Pennsylvania voters placed priority on habitat preservation in an April 2002 poll, and 78 percent supported guaranteed state funding to be used exclusively to protect and improve Pennsylvania's environment.

In the survey for the state's Environmental Readiness for the 21st Century Report, individuals gave the following responses to questions related to biodiversity.

- When asked to identify the meaning of the term biodiversity, 38 percent picked the correct response out of four possible answers. About 40 percent chose not to guess, but rather volunteered a response of "don't know."
- Almost three-fourths (72 percent) correctly chose destruction of habitats by humans as the most common reason an animal species becomes extinct.
- More than half of the people polled (54 percent) recognized the ecological services wetlands provide in cleaning water.
- Approximately 64 percent knew trees were an example of a renewable resource.

Similarly, in a recently released national survey of American attitudes on biodiversity conducted by the Biodiversity Project, people showed a lack of familiarity with the term, but knowledge of the concepts.

- Nearly seven in ten (67 percent) Americans agree that the number of plant and animal species is decreasing while only 8 percent think the numbers are increasing.
- Only three in ten Americans have heard the term "biodiversity," but this figure is significantly higher than the number responding positively to this question in 1996 (19 percent), showing that biodiversity education efforts are working.

SUMMARY

Clearly, a paradox exists in public attitudes and knowledge about biodiversity. While Pennsylvanians show overwhelming support for biodiversity conservation and most have an understanding of specific issues, they perceive themselves as not being knowledgeable about biodiversity.

Perhaps the greatest challenge to reducing threats to Pennsylvania's biodiversity will be gaining the public's willingness to embrace these issues. This is especially true for issues relating to changing land use patterns, as an expanding population seeks to share many of the same resources. An understanding of how the loss of biodiversity is important to all species, including humans, is a key factor in the future success of biodiversity conservation.



Urban Biodiversity

Biodiversity is everywhere – including Pennsylvania's largest cities! Scientists and other naturalists have conducted BioBlitzes – 24-hour surveys looking for all the plants and animals in a given area – in all four major parks in Pittsburgh as well as in Philadelphia's Fairmount Park. In one day, almost 1,500 different plants, animals, and fungi were recorded in Pittsburgh's Schenley Park, from bats to mushrooms and including a bright purple centipede. A BioBlitz in Philadelphia's East and West Park resulted in a total count of 955 plant and animal species. Urban parks are reservoirs of native biodiversity that we can observe and enjoy everyday.



Yellow lady's slipper

Educational Resources



Young groundhog

Educational materials that integrate biodiversity concepts are powerful allies in fostering the conservation of natural resources. The disconnection between the public's lack of understanding of biodiversity and their support for protecting the environment may be attributed, in part, to a lack of educational materials on biodiversity.

SOURCES AND TYPES OF BIODIVERSITY EDUCATIONAL MATERIALS

In compiling information for this report, a questionnaire was sent to government, academic, environmental, and conservation organizations and programs throughout the state, asking about their educational materials related to Pennsylvania biodiversity. Although not extensive, specific materials on biodiversity exist for children and university students (examples of these materials are presented below).

One major gap was very apparent – the lack of educational materials for adults. Training programs on biodiversity and natural history topics exist for teachers, but no continuing education opportunities focusing on biodiversity are currently available to adults in general. Many organizations, such as state parks and nature centers, however, offer occasional programs that emphasize biodiversity issues for adult audiences.

Wild Resource Conservation Fund. Eleven videos on biodiversity themes are available, including specific animals (bog turtles, bats, wood rats, and others), plants, habitats, and conserving biodiversity. Companion materials – bookmarks, buttons, and posters – are available for some of the videos.

World Wildlife Fund. A curriculum supplement, *Windows on the Wild*, uses the topic of biodiversity as a “window” to help learners of all ages explore the intricate web of life. A Pennsylvania-specific version is being field tested through teacher in-service programs and workshops.

Pennsylvania State Resource Agencies. The Pennsylvania Department of Conservation and Natural Resources, the Pennsylvania Fish and Boat Commission, and the Pennsylvania Game Commission use education as a key component of conserving and managing plants and wildlife. Although the term biodiversity has not traditionally been used within their education programs, biodiversity topics include adaptation, predator/prey relationships, ecosystems, and endangered species of Pennsylvania.

Pennsylvania Department of Education. The Pennsylvania Department of Education's Office of Environment and Ecology directs the three largest national environmental education projects: *Project WET*, *Project Learning Tree*, and *Project WILD*. Although the interdependency of life and other biodiversity concepts are dominant throughout each of these programs, they do not specifically refer to biodiversity.

Business and Industry. Business and industry also are involved in biodiversity education in Pennsylvania. For example, PPL Corporation based in Allentown, offers a variety of programs dealing with biodiversity concepts. The Pennsylvania Department of Education and Hardwood Lumber Manufacturers Association of PA, in collaboration with the Northeastern Loggers Association and the Pennsylvania Department of Agriculture's Hardwoods Development Council, developed an educational kit on *Sustaining Penn's Woods: A Sound Use of the Land*. Students look at the three levels of biodiversity (species diversity, genetic diversity, and ecosystem diversity) to gain an understanding of how the interdependence of plants and animals are important to human survival.

Higher Education. The word biodiversity is found in some course titles and descriptions in Pennsylvania colleges and universities, but most pertinent courses concentrate on specific topics and concepts within biodiversity, such as plant taxonomy or zoology.

Professional Scientific Societies. Conceivably, professional scientific societies can do much to assist with biodiversity education. For example, the Ecological Society of America has sponsored several programs at the national level, including Schoolyard Ecology and SEEDS (Strategies for Ecology Education, Development, and Sustainability). The role of those programs toward enhancing biodiversity education in Pennsylvania is unknown.

Habitat Enhancement Programs. A wide variety of educational groups in Pennsylvania offer habitat enhancement programs, including nest box programs, maintenance of riparian buffers, and butterfly counts. Only a few of these use the term biodiversity in their descriptions.

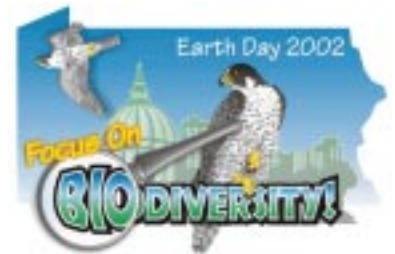
Biodiversity Focus in 2002

In 2002 biodiversity received special attention across Pennsylvania. Biodiversity was selected as the theme for the Department of Environmental Protection's (DEP) Earth Day celebrations. In addition to being the focus of DEP's Earth Day publicity, biodiversity packets were distributed to every school and public library in the state.

Biodiversity 911, a traveling exhibit developed by the World Wildlife Fund, was on display during the summer of 2002 at the Academy of Natural Sciences in Philadelphia and the Carnegie Museum of Natural History in Pittsburgh.

The 2002 annual conferences of several groups focused on biodiversity, including the Pennsylvania Coldwater Conference hosted by Pennsylvania Trout Unlimited and the Environmental Issues Conference sponsored by Kings Gap Environmental Education and Training Center in collaboration with Shippensburg University.

National Envirothon, an environmental competition for Grades 9-12, designated their 2002 issue as Invasive Species and Their Effect on Biodiversity.



State Academic Standards

The inclusion of biodiversity in the recently adopted Pennsylvania Academic Standards for Environment and Ecology will greatly assist in increasing knowledge of the concept of biodiversity. The standards establish a rigorous knowledge level that students are expected to achieve by the end of Grades 4, 7, 10, and 12. While the term "biological diversity" is only used in the Environmental Health Standard, the concept of biodiversity supports many of the other Environment and Ecology Standards, such as Threatened, Endangered, and Extinct Species; Renewable and Nonrenewable Resources; Agriculture and Society; Ecosystems and Interactions; and Humans and the Environment.

Active Learning. Although biodiversity education lends itself to active learning experiences, these types of programs are mostly in the planning stages. For example, the Pennsylvania Spatial Data Access system, Pennsylvania's official geospatial information clearinghouse, has proposed a *Pennsylvania Biodiversity Explorer Program*. This program would facilitate exploration of Pennsylvania's natural biological heritage by making biodiversity data easily available to a broad range of users.

SUMMARY

More than 90 organizations, representing all sectors from the forest products industry to higher education, reported some involvement in biodiversity education programs. Although concepts related to biodiversity were reported in many programs, the subject was often limited to individual species or habitats rather than interrelationships among species. Explanations of why species have become endangered or threatened, recovery plans, and critical habitat designations were rarely addressed.

In general, the public appears to be quite broadly aware of basic concepts about biodiversity, but the failure for that term to be used with those concepts has left the public uncertain or vague about what it means. To get the public to learn what biodiversity is, the term will have to be used explicitly when talking about biodiversity concepts and issues.



Even with extensive technological advances and modern conveniences, our survival still depends on natural resources. Conservation of biodiversity in Pennsylvania is essential not only for Pennsylvanians, but also is a critical linking thread in the global web of life.

Best Management Practices for Biodiversity

G

iven our dependence on biological resources for survival, people have greatly disturbed natural habitats in Pennsylvania. In attempting to mitigate these impacts, we must not assume that no management is best for biodiversity. Best management practices (BMPs) (including “best stewardship practices”) have become widely recognized and accepted as one of the most effective approaches for managing natural resources on both public and private lands.

As most of the land in Pennsylvania, and thus most of its biodiversity, is in private hands, biodiversity conservation can be achieved only if the stewards of private lands have the education, tools, and will to make it happen. Some of these tools are in the form of voluntary, non-regulatory BMPs tailored to specific types of land use practices, such as agriculture, forestry, and residential developments. While most practices do not specifically target biodiversity, more recent ones include management activities that address biodiversity.

We must not assume that no management is best for biodiversity.

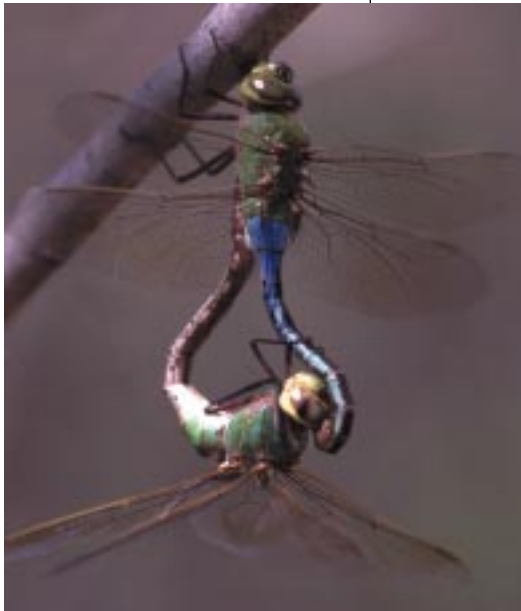
EVOLUTION OF BEST MANAGEMENT PRACTICES

The evolution of BMPs from addressing only specific environmental degradation to embracing habitat restoration and biodiversity issues is exemplified by the Pennsylvania Forestry BMPs developed by the Cooperative Extension Service at Pennsylvania State University in cooperation with the forest products industry, forest landowners, and other groups. Initially, forestry BMPs were directed only at reducing water pollution from erosion and sedimentation. They eventually were expanded to address both water quality and wetlands protection issues because of their impact on wildlife habitat and threatened and endangered species. Currently, many forestry management practices in Pennsylvania directly integrate biodiversity conservation with measures for increased yield of timber and healthy forests.

Today there are a number of BMPs applicable to biodiversity in Pennsylvania. These documents cover a wide spectrum of community types and human activities (see Appendix for a list of selected management practices for enhancing biodiversity). The Pennsylvania Forest Stewardship Program presents a good model for landowner-friendly BMPs. The recommendations address issues where there is limited knowledge by applying the approach of the Hippocratic oath – “do no harm.”

Consistent with the “do no harm” approach, these practices recommend minimizing habitat loss by managing for vertical structural diversity. The BMPs recommend preserving habitat for wildlife and plants in each of the different forest layers – forest floor, understory, midstory, and canopy – and note the importance of snags, logs, and cavity trees for wildlife habitat. The “do no harm” approach is also evident in BMPs that recommend preservation of unusual, rare, threatened, and endangered species and their habitats as well as habitats of exceptional value.

The Pennsylvania forestry best management practices, like virtually all biodiversity-oriented BMPs, recommend maintaining corridors between habitats to allow migratory pathways and prevent isolation of habitat “islands.” They further recommend minimizing the amount of habitat edge, using buffer areas around streams, and maintaining wooded corridors as connections between habitats.



Mating green darners

SUMMARY

While some best management practices provide recommendations for conserving biodiversity, there is little research on the impact of implementing these recommendations. Therefore, it may be difficult to develop reliable indices of success given the presence of multiple influences, varying land use, and different management practices in the field. Special attention must be given to developing cost-effective BMPs with sufficient sensitivity for assessing changes in biodiversity.

The problem of changing situations and limited knowledge suggests that procedures for periodic reassessment should be included in biodiversity BMPs. The ambiguities and knowledge limitations also suggest avoiding broad, simplistic rules such as “clean up land to its condition in 1680.” Nevertheless, these limitations do not suggest inaction in the face of known threats to biodiversity globally and losses in Pennsylvania. The use of best management practices means employing the best practices that are currently available.

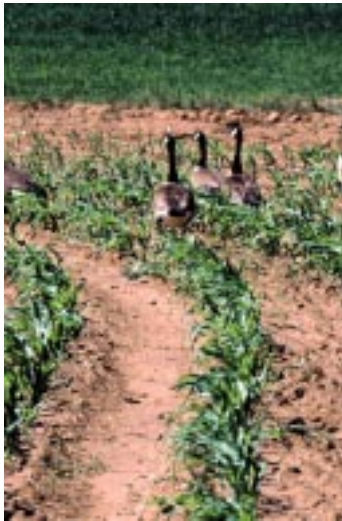
Limitations in our knowledge do not suggest inaction in the face of known threats to biodiversity globally and losses in Pennsylvania.

A photograph of a box turtle resting on a patch of green grass. The turtle's shell is dark brown with prominent yellowish-orange spots and patterns. Its head and front legs, which also feature yellow spots, are visible. The turtle is facing towards the right side of the frame.

Land Protection Practices

Box turtle

Land protection activities, including land acquisition, regulations, incentives, education, and most important, good stewardship by private landowners, are all components of biodiversity conservation. Land protection practices include the strategies used to determine what lands to protect as well as the methods used to carry out these efforts.



STRATEGIES

Strategies used to protect land in Pennsylvania are primarily contained in the Endangered Species Act (ESA), the Pennsylvania Natural Diversity Inventory (PNDI), The Nature Conservancy's Conservation by Design strategy, and the Smart Conservation Strategy.

Endangered Species Act. The principal federal strategy for protecting land to conserve biodiversity is embodied in the federal Endangered Species Act (ESA). ESA adopts the "fine filter" approach of protecting biodiversity by focusing efforts on protecting critical habitat for nationally threatened or endangered species.

Pennsylvania Natural Diversity Inventory. The Pennsylvania Natural Diversity Inventory collects, identifies, and describes the Commonwealth's rarest species and most significant ecological features. PNDI provides information used by state regulatory agencies for permit decisions as well as the regulatory enforcement to ensure protection for threatened and endangered species.

Conservation by Design. The Nature Conservancy's Conservation by Design strategy uses both a coarse filter (communities and ecological systems) and a fine filter (species) approach for both ecoregional and site-specific planning and implementation.

Smart Conservation Strategy. The Natural Lands Trust/Pennsylvania Environmental Council's Smart Conservation Strategy, presently under development for southeastern Pennsylvania, will provide a system for land trusts and local governments to prioritize lands for protection in order to conserve biodiversity. This strategy is developing a method of prioritizing properties for conservation based on a site's value for biodiversity, the imminence of threat, and public support.

METHODS FOR IMPLEMENTING STRATEGIES

Methods for implementing land protection strategies can be divided into three groups.

- Methods traditionally used by government agencies.
- Practices traditionally used by enterprises and private entities, but increasingly used in government programs.
- Knowledge building tools used by both government and private organizations.

Government Agencies. Land protection strategies traditionally used by government agencies include regulation; land acquisition, ownership, and management; and loans, grants, taxes, fees, and other incentives.

Regulation is the control technique most commonly associated with governmental protection of environmental resources. Regulations provide the precise standards for defining when and where a method may be used, along with encouraging conservation of biodiversity.

Land acquisition has traditionally been an effective method for conserving biodiversity. Numerous federal, state, and local public entities have the authority to acquire and manage land.

- Pennsylvania's Open Space Law provides authority for the Department of Conservation and Natural Resources, Department of Agriculture, and municipal governments to acquire open space to meet a broad range of objectives including biodiversity conservation.
- The Pennsylvania Game Commission is authorized to acquire lands by purchase through the Game Fund or donation to add to the system of State Game Lands. Over the last two decades, PGC has been a major purchaser of lands in the state and now manages 1.4 million acres of game lands in 300 separate tracts.
- The 2001 Conservation and Preservation Easement Act specifies that conservation easements can be created and held for a broad array of conservation purposes, including conserving natural resources and protecting wildlife.
- Pennsylvania's Municipal Planning Code, Township Code, Environmental Improvement Compacts Law, and Open Space Law authorize acquisition of land by local governments and authorities.

Loans, grants, taxes, fees, and incentives offer numerous opportunities to advance land protection.

- Loans and grants, provided by state and federal government agencies, are among the most frequent methods used to fund land protection. These loans and grants provide states, municipalities, or private parties support for the planning, investigation, and acquisition of lands or easements, as well as implementation of management plans.
- Federal, state, corporate, and personal tax policies provide tax incentives for the protection of land to promote biodiversity. The federal tax deduction for the donation of a conservation easement to a conservation organization is a frequently used means of protecting land.
- The Pennsylvania Clean and Green program is another land protection program that reduces real estate tax assessments for property maintained as open space, agricultural, or forest lands for a period of at least ten years.
- Fees imposed on the use of public land for recreation, such as camping, hunting, fishing, and rental of facilities, are another means for generating funds to support both land acquisition and management.

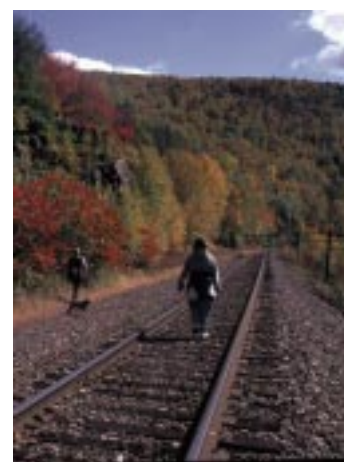
Predominantly Private Practices. Practices more typically used in the private marketplace are increasingly being used for environmental protection. Tools with an enterprise component include partnerships, property rights related programs, and certification programs.

Public-private partnerships are often formed to help with education, research, or technical and financial assistance.

- PNDC is a partnership of two private conservation organizations – The Nature Conservancy and Western Pennsylvania Conservancy – and the Department of Conservation and Natural Resources.
- The Pennsylvania Biodiversity Partnership is another example of a public-private partnership that combines the information and expertise from various interests to advance biodiversity conservation.

Private-private partnerships involve private non-profit corporations and for-profit individuals and organizations. Examples of these partnerships include:

- Land trusts that join together to provide maximum funding for land protection.
- Coalitions of non-profit and for-profit organizations that team together to allow the for-profit partners limited development or resource utilization in exchange for funds to acquire title to biologically important lands or conservation easements.



Lehigh River gorge

Private acquisition of property rights by more than 150 local land trusts comprises a major portion of land protection efforts in Pennsylvania. Most land trusts protect land by acquiring it or by using conservation easements.

Transfer development rights and in-lieu or impact fees are additional private property rights tools for land protection. For instance, rather than providing open space within a new development, a developer might voluntarily pay an in-lieu or impact fee to purchase open space elsewhere. The transfer of development rights allows municipalities to protect valuable land by prohibiting development, yet preserving the rights of the landowner. This is achieved by awarding landowners transferable development rights that can be sold to other parties for developing their properties to greater density.

Trading programs are an increasingly popular means of reducing the costs and burdens of environmental protection. Trading programs involve the authorization of "banks" by government or private entities, such as the wetlands mitigation banks established by the Department of Environmental Protection. These trading programs encourage development of wetland restoration and creation projects that can be "banked" and sold to parties requiring mitigation measures under federal or state wetlands protection programs.

Certification is another enterprise tool being used by environmental groups and industry to promote good natural resource management, and indirectly conserve biodiversity. Various programs, especially those associated with certification for sustainable forestry, such as the Forest Stewardship Council and Sustainable Forestry Initiative, reward companies by informing their customers and stockholders that they implement sustainable practices.

Education and Research. The third broad set of tools for advancing land protection is building knowledge through education and research activities. Many government and private conservation organizations have environmental education as an important component of their activities. Research projects on biodiversity are found at universities, government agencies, and museums as well as at some environmental groups and land trusts. Examples of education initiatives include:

- Landowner educational programs funded under Growing Greener to promote biodiversity through stream fencing and other watershed related programs.
- Cooperative extension programs to provide educational materials to landowners on the recreational and economic advantages of maintaining land in a natural condition.

SUMMARY

Land protection is one of the most important components of biodiversity conservation efforts. Conservation of natural habitats is critical to the species dependent upon those habitats. Disturbance created by land development or other uses directly impacts plants and animals and can cause losses of both species and genetic diversity. Land use changes may also introduce invasive species, predators, and pollutants that can have the same effect. Land protection is broadly defined as the land-use activities that maintain or enhance biodiversity. These activities range from the preservation of land in its natural state; to the conservation of open space land in active use, but managed to promote biodiversity; to the management of land to conserve biodiversity in developed areas.

There are a variety of tools available in Pennsylvania to protect land ranging along a continuum from land and easement acquisition to education. These tools are frequently used in conjunction with one another, with multiple tools often employed in a single effort. Strategies are essential to determine where and how these tools should be targeted and coordinated. Such coordination is essential to achieve the ultimate goal of biodiversity conservation throughout the Commonwealth.



Conservation of natural habitats is critical to the species dependent upon those habitats.



Habitat Restoration and Species Reintroductions

W

hen best management practices and land protection efforts fail at conserving biodiversity, the remaining option is to attempt to restore or reintroduce what has been lost. Restoration and reintroduction projects have been somewhat successful in counteracting the loss of species and habitats in Pennsylvania. These projects have taken many forms, ranging from wetland restoration and fire management to replanting native grasslands and translocating animals to their former ranges.

HABITAT RESTORATION

Concerted efforts have been made, especially in the 1990s, to restore or repair habitat damage. Most efforts in Pennsylvania have focused on aquatic areas rather than terrestrial ones, with the exception of sites disturbed by former industrial uses (brownfields).

Wetland restoration and creation of new wetlands have been advanced by recognition of the ecological services that wetlands provide. While replacing wetlands on an equal area basis is the emphasis of most mitigation projects, there is less concern for replacing ecological functions. In addition, many mitigated wetlands are being replaced with dissimilar wetland types. For instance, while the greatest loss of wetlands has been of the scrub-shrub type, most restored wetlands are open water types, which have lower ecological value.

Despite initial optimism that created wetlands would perform the same functions as native wetlands, recent evidence suggests this is not the case. Poor wetland design, inability to establish vegetation, and the influx of invasive species are some of the reasons that wetland mitigation projects fail. In spite of such evidence, some argue that created wetlands have not been given sufficient time to achieve all of their potential ecological functions.

Terrestrial habitat restorations in Pennsylvania are attempting to establish grassland habitats on former agricultural lands, abandoned mine sites, and other disturbed areas. Abandoned mine sites, in particular, offer opportunities for creating grasslands that can attract birds and other species that prefer these habitats. Raptors such as northern harrier and American kestrel, for example, use reclaimed lands in western Pennsylvania.

REINTRODUCTIONS

Throughout the last century, several species of animals ranging from river otters to elk have been reintroduced to Pennsylvania with mixed success. For some projects, however, many additional years are needed before success can be assessed. While the definition of success varies, progress has been made especially with larger mammals and birds. Nevertheless, the difficulties and especially the high costs of many reintroduction efforts are a reminder that replacement is not a substitute for biodiversity conservation.

The majority of active reintroductions in Pennsylvania involve larger mammals, birds, or fish. These include game species such as elk, turkey, and American shad as well as raptors such as bald eagle and peregrine falcon. In many cases, animal species have been able to naturally recolonize in restored habitats, but often additional measures such as translocation of animals from other regions is necessary. And some reintroductions, such as the peregrine falcon, have had a great deal of human involvement.

American Shad. Until dams impeded their travel, American shad returned each year to the headwaters of the Susquehanna River in New York. Hundreds of thousands of fish migrated annually through Pennsylvania and were an important food source for settlers and American Indians. Although populations of shad survived below the last canal dam at Columbia, water pollution, failed fish passages, and overharvesting led to their decline.



River otter



With the establishment of four hydroelectric dams on the lower Susquehanna River in the early part of the 20th century, nearly all species of migratory fish, including shad, disappeared from the Susquehanna. Problems in the upper Chesapeake Bay due to overfishing, pollution, and flooding continued after 1971, resulting in closing of the shad fishery in Maryland by 1980.

American shad reintroduction efforts started in 1971 with the construction of a fish elevator on the Conowingo Dam and placement of 200 million eggs in hatching boxes in the river. The goal of this multi-million dollar project was to restore an annual spawning population of two million shad within 25 years. Fish lifts along three other dams on the Susquehanna River helped in the effort. At the Conowingo Dam alone, the number of returning shad has increased to a current average of more than 45,000.

River Otter. River otters declined in Pennsylvania in the 1800s and early 1900s due to habitat loss and unregulated hunting. By the 1950s, populations were limited to the Pocono Mountains. In 1982, river otters captured in New York and New Hampshire were released in Pennsylvania. In the 1990s, 82 river otters were reintroduced to five stream and river systems, primarily in northern counties that are densely forested and sparsely populated. A 1994 survey located otters in at least 47 counties. Of the 25 established populations in the state, nine are considered to be expanding, 12 stable, and four declining or unknown. Water quality problems due to pollution from sources such as abandoned mine drainage are the greatest impediment to river otter reintroduction. Accidental trapping is also a cause of mortality, with 87 otters accidentally killed between 1989 and 1994.

Wild Turkey. Probably one of Pennsylvania's greatest reintroduction success stories is the wild turkey. Wild turkeys were eliminated in most of the eastern United States, including Pennsylvania, by the late 1800s due to overhunting and habitat loss by logging. Attempts were made throughout the 20th century to reintroduce wild turkey in Pennsylvania. Ultimately, a trap and transfer program begun in 1956, coupled with the return of preferred habitat and expansion of the remaining turkeys' range, led to their successful comeback. The population of wild turkeys was estimated at more than 400,000 birds in 2000 and continues to increase each year. Today, wild turkeys are found in every county in Pennsylvania, and are regularly seen in Pittsburgh and the Philadelphia suburbs.



Wild turkey

Fire as a Management Tool

Historically, natural fires were essential in maintaining forest openings and certain specialized habitats, such as serpentine barrens. Over the course of the last century, the total acreage subjected to fire in Pennsylvania decreased by more than 99 percent due to fire suppression and control measures. Impacts on biodiversity include replacement of oak species in Pennsylvania forests with maple and black cherry, and invasion of oaks and pines into the serpentine grasslands.

Periodic burning is critical to maintaining fire-dependent habitats. Controlled burns are one of the management tools used in preserving habitats such as barrens. Plants like serpentine aster and hairy chickweed, both endangered species, benefit from prescribed burning to remove encroaching woody plants.



SUMMARY

The science of restoration ecology has emerged relatively recently. Many questions remain regarding our ability to restore degraded habitats as well as the best methods for translocating species into their former locations. Although habitat restorations or species reintroductions are possible in many situations, some areas have changed too drastically to be restored to their original states or to support populations of reintroduced animals.

Loss of habitats and species will likely never be fully reversed, but restoration work and reintroduction of species into areas they formerly occupied can mitigate some of the damage. These efforts, however, will never be adequate substitutes for the conservation of biodiversity.



Mountain laurel

Government Organizations and Programs

State, federal, county, and local governmental organizations all have a role in managing the lands, waters, and biological resources of Pennsylvania and can have significant influence on biodiversity conservation.

Pennsylvania adopted an Environmental Master Plan in 1977, with overall environmental goals of (1) protecting natural processes and ecological relationships and (2) preserving natural, scenic, and esthetic values of the environment while meeting society's needs. While this plan was intended to be a mechanism for coordinating activities to achieve the state's environmental goals and even included mandates for a "biological survey of the Commonwealth," it has not been part of the actual process.

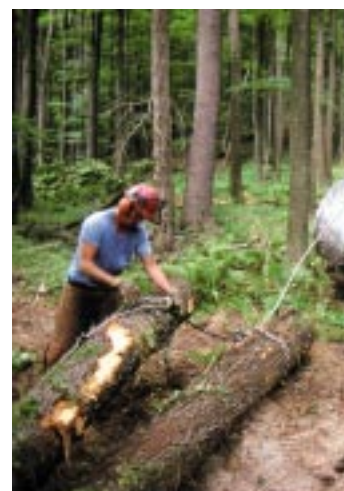
STATE GOVERNMENT

In practice, natural resource conservation is carried out through several state agencies. The state agencies with legislated responsibility for biodiversity in Pennsylvania are the Department of Conservation and Natural Resources (DCNR), Department of Environmental Protection (DEP), Pennsylvania Fish and Boat Commission (PFBC), and Pennsylvania Game Commission (PGC). Other state agencies also impact biodiversity, although coordination among these agencies has often been ad hoc.

State Government Agency	Role in Protecting Biodiversity
Department of Conservation and Natural Resources (DCNR) – primary agency for biodiversity protection	<p>Established in 1995, DCNR has authority for:</p> <ul style="list-style-type: none"> • State parks and state forests. • Pennsylvania's ecological heritage and geologic features. • Waterways and greenways. • Community open space, conservation, and recreation grants. • Wild plants.
DCNR: Bureau of Forestry	<ul style="list-style-type: none"> • Oversees one of the largest state forest systems in the nation with more than 2.1 million acres.
DCNR: Bureau of State Parks	<ul style="list-style-type: none"> • Manages 116 state parks on 283,000 acres. • Protects 22 areas of unique scenic, geological, or ecological value in the parks.
DCNR: Bureau of Recreation & Conservation	<ul style="list-style-type: none"> • Awards millions of dollars in conservation grants to local governments and nonprofit organizations each year. • Administers Pennsylvania's eleven heritage parks (broad geographic areas significant for tourism, history, and conservation).
DCNR: Office of Wild Resource Conservation	<ul style="list-style-type: none"> • Administers the Wild Resource Conservation Fund (WRCF). • Funds projects that aid in the conservation of wild plants and non-game animals and County Natural Areas Inventories. • Produces educational materials on biodiversity, including posters, videos, patches, and a newsletter.
DCNR: Pennsylvania Natural Diversity Inventory (PNDI)	<ul style="list-style-type: none"> • Pennsylvania's Natural Heritage Program. • Cooperative effort among the Bureau of Forestry, Western Pennsylvania Conservancy, and The Nature Conservancy. • Collects and disseminates information on endangered, threatened, and rare species and on natural community types and ecosystems. • Data used by state agencies, local governments, and consultants in planning and designing projects, and especially in avoiding impacts on threatened and endangered species and significant natural communities.
Other DCNR Initiatives Pennsylvania Greenways Action Plan	<ul style="list-style-type: none"> • Plan completed in August 2001 with a goal to support greenways plans for all counties by 2007. • In public surveys conducted for this Plan, protection of natural resources and providing habitat for wildlife were ranked as the two most important functions of greenways.
Office of Biodiversity Conservation (proposed)	<ul style="list-style-type: none"> • First Biodiversity Director hired in 2001. • Developing biodiversity strategy for DCNR.

Forest Certification

In 1998, all of Pennsylvania's state forests – 2.1 million acres – were provisionally certified as being managed according to recognized standards of sustainability, making Pennsylvania's state forests the largest block of certified forest under single public ownership in the nation, and possibly, the world.





Paddlefish Reintroduction

Looking like a creature from the prehistoric past, paddlefish were likely gone from the Pennsylvania drainage of the Ohio River by 1919 due to polluted waters, river channelization, and dams. Improvements in the water quality in Pittsburgh's three rivers, and the return of other fish to this area, indicate that paddlefish should be able to survive in these waters again. Their reintroduction in the state began in 1991, with release of paddlefish into the Ohio and Allegheny Rivers. Because female paddlefish can take up to 10 years to reach reproductive age, it will take many years to determine the success of this project. Since 1992, there have been 12 sightings of paddlefish in Pennsylvania. Unfortunately, two of these were found dead.



State Government Agency

Role in Protecting Biodiversity

Department of Environmental Protection (DEP) – primary regulatory agency for environmental protection

- Implements and enforces laws on air pollution; water quality; mining; oil and gas development; radiation; solid and hazardous waste management; recycling; hazardous site cleanup; and pollution prevention.
- Administers more than 90 types of permits for activities affecting lands and waters. Some permit review procedures require that applicants consult PNDI to determine if threatened or endangered species may be affected by the proposed project.
- Developing outcome measures for Pennsylvania's environmental health, including two indicators (out of 17) relating to biodiversity.

Pennsylvania Fish and Boat Commission (PFBC)

- Provides fishing and boating opportunities to the public through the protection and management of aquatic resources.
- Responsible for both game and non-game aquatic biodiversity, including fish, amphibians and reptiles, and aquatic insects.
- Establishes fishing seasons, limits, and rules.
- Engages in stocking state waters.
- Revenue provided from license fees.

Pennsylvania Game Commission (PGC)

- Protects, propagates, manages, and preserves the game and wildlife of Pennsylvania.
- Maintains 1.4 million acres of state game lands.
- Issues rules and regulations for the management of mammals and birds, including authority to protect bird and mammal species, close areas to hunting and trapping, and adjust hunting and trapping regulations to regulate animal populations.
- Manages wildlife populations at biologically and socially acceptable levels.
- Revenue provided from license fees.

Pennsylvania Department of Agriculture

- Programs relevant to biodiversity include:
- Plant pests and noxious weed control.
 - Farmland protection.
 - Promotion of sustainable agriculture and forestry.

Pennsylvania State Conservation Commission

- Responsible for oversight and support of Pennsylvania's 66 county conservation districts.

Pennsylvania Department of Transportation (PennDOT), State Transportation Commission, and Pennsylvania Turnpike Commission

- Significant impact on patterns of development and habitat protection as a result of their decisions to locate new roadways.
- Required to perform environmental reviews for federally funded highway projects that may have significant impact on the environment.
- Often consult PNDI for information on potential impact on species and habitats.

Department of Community and Economic Development

- Houses the Governor's Center for Local Government Services, which is responsible for land use planning assistance.
- Required to issue a land use and growth management report for Pennsylvania by 2005 and every five years thereafter.

Pennsylvania Department of Military and Veterans Affairs and Pennsylvania Army National Guard

- Manage military installations in the state, including site of only known population in Pennsylvania of the regal fritillary, a rare butterfly.

FEDERAL GOVERNMENT

As in state government, several federal agencies play a role in biodiversity conservation in Pennsylvania.

Federal Government Agency Role in Protecting Biodiversity

Environmental Protection Agency	<ul style="list-style-type: none"> • Responsible for oversight of programs administered by DEP that implement federal legislation to protect air, water, and land from pollution. • Provides grant funding supporting state actions to protect the environment. • Offers technical assistance to landowners and communities regarding conservation efforts.
National Park Service	<ul style="list-style-type: none"> • Manages several sites in Pennsylvania, including Gettysburg National Battlefield Park and the Delaware Water Gap National Recreation Area. • Administers grant programs.
U.S. Army Corps of Engineers	<ul style="list-style-type: none"> • Issues permits for dredging or filling wetlands and other waters following an environmental review process. • Enforces wetlands laws. • Manages land in Pennsylvania primarily for flood control and also recreational uses.
U.S. Department of Agriculture, U.S. Forest Service	<ul style="list-style-type: none"> • Manages Pennsylvania's 513,000-acre Allegheny National Forest. • Provides technical assistance and funding to assist private forest landowners. • Conducts forest research in Pennsylvania.
U.S. Department of Agriculture, Natural Resources Conservation Service	<ul style="list-style-type: none"> • Provides technical assistance to farmers. • Helps administer cost-share programs for land conservation along with the USDA Farm Services Agency.
U.S. Fish & Wildlife Service	<ul style="list-style-type: none"> • Administers the federal Endangered Species Act. • Conducts research and provides comments on proposed permitting activities.



Regal Fritillary

The regal fritillary, a rare butterfly, once ranged from the East Coast to the Great Plains. While many western populations still remain, only two populations are known in the east – a large population at Ft. Indiantown Gap in Pennsylvania and a small population in Virginia. The Pennsylvania Department of Military and Veterans Affairs and Pennsylvania Army National Guard are responsible for the management of this rare butterfly and have partnered with The Nature Conservancy to develop and implement a conservation program.

COUNTY AND LOCAL GOVERNMENT

Most land use planning and development decisions are made at the local level and thus county and local government initiatives are critical to the success of any statewide biodiversity conservation strategy. Each of Pennsylvania's 2,568 local governments has full authority over land use planning, zoning, and subdivision regulation. This makes coordination of land use planning and protection of biodiversity more difficult than it is in states where land use is regulated at a larger geographic scale, such as at the county level.

Amendments to the state's Municipal Planning Code (MPC) provide opportunities for coordination between municipalities, which is important for biodiversity conservation since most factors influencing habitats and ecological communities occur at a scale that transcends municipal boundaries. Communities may now coordinate planning and land use decisions with one another without engaging in joint planning. The MPC amendments also authorize municipalities to enter into cooperative agreements to adopt joint comprehensive plans without giving up their separate zoning boards and planning commissions. Cooperating municipalities may designate "rural resource areas" in which uses like forestry and agriculture will be encouraged and enhanced.



County and Local Government Initiatives

Role in Protecting Biodiversity

County Comprehensive Plans

- All counties are required to adopt comprehensive plans.
- 60 out of 67 counties have completed plans.
- Plans are not binding on zoning or land use regulation by municipalities that undertake their own planning and zoning.

Municipal Comprehensive Plans

- Cities, boroughs, and townships have authority for comprehensive planning and adoption of zoning and subdivision ordinances that control the type, scale, and location of development.
- 57 percent of Pennsylvania's municipalities have comprehensive plans.
- Municipalities can acquire and hold open space lands.

Municipal Planning Code (MPC)

- Requires municipal comprehensive plans to address land use issues, including provisions for public grounds, parks and recreation, as well as preservation of prime agricultural lands, floodplains, and other areas.
- Growing Smarter amendments covering protection of natural and historic resources, such as wetlands, woodlands, and unique natural areas were added to MPC in 2000.

Zoning Ordinances

- Govern land development and use in municipalities.
- 64 percent of municipalities have enacted zoning or are covered by county zoning regulations.
- May regulate land use for the protection of natural resources and may contain provisions to protect environmentally sensitive areas.

Subdivision Ordinances

- Most common form of land use control in Pennsylvania.
- Control how land is subdivided into smaller parcels and impose basic requirements on building setbacks and locations.
- 93 percent of municipalities regulate subdivision of land or are covered by county subdivision ordinances.

Environmental Advisory Councils

- Formed by municipalities to inventory natural resources, identify environmental problems, and obtain information on open space.
- Make recommendations and advise on land acquisitions.

SUMMARY

All levels of government – from local municipalities to the federal government, each with many different agencies – are involved in biodiversity conservation in Pennsylvania. Although these multiple government units provide many tools, they have sometimes lacked coordination in matters of land use and biodiversity conservation.

A photograph of a person fishing in a river. The person is standing in the water, casting a line. The background is a dense forest with tall trees. The water is dark and calm.

Important Laws and Policies

Penn's Creek

A

lthough some laws protecting the environment existed prior to the 1960s, there was no concerted effort to protect Pennsylvania's air, land, or water, or laws regulating use of public natural resources in the state. With passage of the Environmental Rights Clause to the Pennsylvania Constitution (see pg. 1), the government's attitude changed to one of trustee for public natural resources. This amendment also declared that the citizens of Pennsylvania have a right to a healthy environment.

This amendment serves as a guide for conservation activities by the Commonwealth and it also applies to local governments. Its wording creates a public trust in the public natural resources of the Commonwealth, and it also guarantees public rights in preservation of natural values in the environment.

Pennsylvania has numerous laws and policies that relate to biodiversity conservation. These include laws that govern public and private actions affecting lands and waters as well as ones specifically addressing conservation and restoration objectives. Other laws and policies address what biological information is collected, how it is organized, how it is made available to public and private decision-makers, and what requirements or incentives exist to ensure its use.

Beaver lodge



Regulation of invasive species not native to Pennsylvania is divided among agencies with no formal coordination of activities.

LAWS AND PROGRAMS FOR PLANT AND ANIMAL SPECIES

Threatened and Endangered Species. The Federal Endangered Species Act imposes limits on activities affecting federally-listed threatened or endangered species within Pennsylvania. Pennsylvania laws provide additional protection to federally-listed species, as well as to species listed by Pennsylvania agencies as threatened, endangered, rare, or of conservation concern. The Pennsylvania Game Commission (PGC) has jurisdiction over birds and mammals; the Pennsylvania Fish and Boat Commission (PFBC) is responsible for fish, amphibians, reptiles, and other aquatic organisms; and the Department of Conservation and Natural Resources (DCNR) protects plants. Terrestrial insects, spiders, snails, and other terrestrial invertebrates, which make up most of the biodiversity in the state, do not fall under the jurisdiction of any agency. There are no Pennsylvania laws requiring state agencies to adopt habitat protection requirements or to prepare and implement recovery plans.

The Wild Resource Conservation Act provides DCNR with jurisdiction over rare and endangered plants. It directs DCNR to classify plants, authorizes wild plant management permits for the transplantation and management of threatened and endangered plants, and authorizes acquisition of lands or aquatic habitat for public wild plant sanctuaries. DCNR may also designate sites as private wild plant sanctuaries upon request. While this does not give much additional protection, it does give recognition to these sites and provides for transplantation and propagation of species of conservation concern.

The Pennsylvania Biological Survey, a voluntary non-profit organization with members who are scientific experts, assists the state agencies in determining which species to list for conservation concern and their appropriate ranks.

Invasive Species. Regulation of invasive species not native to Pennsylvania is divided among agencies with no formal coordination of activities. PGC can prohibit the possession, importation, exportation, or release of any birds or mammals considered to be dangerous to the general public or wildlife of Pennsylvania. PFBC has similar authority over fish, reptiles, and amphibians.

Invasive plant laws are administered primarily by the Pennsylvania Department of Agriculture. The Noxious Weed Control Law allows designating plants as noxious weeds if they injure public health, crops, livestock, agricultural land, or other property. The law included four noxious weeds – marijuana, Canada thistle, Johnson grass, and multiflora rose – and about a dozen plants have been added to the list, including purple loosestrife, several types of thistles, kudzu, mile-a-minute weed, and jimsonweed. Sale or propagation of noxious weeds is prohibited.

The Pennsylvania Plant Pest Act defines plant pests as any organism that causes injury or damage to plants or plant products. The Department of Agriculture may declare a pest a public nuisance, and make its existence, maintenance, importation, transfer, or sale unlawful. The Pennsylvania Seed Act prohibits the sale of noxious weed seeds and plant parts.

LAWS AND PROGRAMS RELATED TO WATER

Pennsylvania's Clean Streams Law is the cornerstone of the state's aquatic protection programs and also provides some regulation of activities affecting terrestrial habitats. By law, every stream or waterbody in Pennsylvania has an assigned designated use as Warm Water Fishes, Trout Stocking Fishery, Cold Water Fishes, or Migratory Fishes.

In addition, streams with excellent water quality may be designated High Quality Waters (HQ) or Exceptional Value Waters (EV). The water quality in an HQ stream can be lowered only if a discharge is the result of necessary social or economic development, with all existing uses of the stream protected. EV waters are to be protected at their existing quality.

The Clean Streams Law further emphasizes the importance of clean, unpolluted waters through objectives to prevent further pollution as well as to reclaim and restore every polluted stream in Pennsylvania. Pennsylvania, like other states, is subject to the federal Clean Water Act, which requires that impaired waters and their sources of impairment be identified and plans developed to remove the impairment.

Wetlands and waterways also are protected in Pennsylvania under the Dam Safety and Encroachments Act. These regulations provide special protection for:

- Exceptional value wetlands, defined as habitat for threatened or endangered species or hydrologically connected to such habitat.
- Wetlands in or along the floodplain of exceptional value waters or wild and scenic rivers.
- Wetlands that support public drinking water supplies.
- Wetlands in state-designated natural areas or wilderness areas.

LAWS AND PROGRAMS FOR PRIVATE LANDS AND ACTIVITIES

Agricultural Lands. Agricultural lands can at times serve as core areas for biodiversity, provide connections between other habitat areas, and are potential areas for future restoration. For land to be designated as a Pennsylvania Agricultural Security Area, it must be used for production of crops, livestock, or livestock products, broadly defined as horticultural products, timber, wood and wood products, and aquatic plants and animals and their byproducts.

Perhaps Pennsylvania's largest publicly funded conservation acquisition program is its Agricultural Easement Program. Through this initiative, conservation easements are acquired to maintain farmland as open space and prevent development. As of December 2001, the program had acquired easements on 212,707 acres on 1,764 farms in 51 counties. Although primarily a program to conserve farmland, these easements may also help conserve populations of native plants and animals that inhabit open fields and edges.

Forest Lands. Forests cover 17 million acres of Pennsylvania – more than half of the state – with nearly 75 percent of these lands privately owned. Pennsylvania has more than 500,000 forest landowners with the median tract size less than 20 acres. DCNR's Bureau of Forestry does not regulate forestry activities on private lands, but it does provide technical assistance, education, insect control, and fire protection.

The sediment and erosion control provisions of Pennsylvania's water quality laws require detailed water quality plans for any timber harvesting and road construction. Use of voluntary forestry best management practices is generally the basis for determining compliance with these regulations.

Pennsylvania's Dam Safety and Encroachment Act provides protection for forested wetlands. While these provisions do not require permits for timber harvests, they do require permits for constructing roads over streams, depositing material for road construction or skid trails, and other activities.

At the local level, Pennsylvania law allows municipalities to adopt ordinances to regulate forestry, but prohibits local governments from unreasonably restricting forestry activities. Local governments may adopt requirements for tree conservation and mitigation when forest land is under development or subdivision.

Other Lands. Under Pennsylvania law, non-coal mines must submit reclamation plans and provide for postmining revegetation of the reclaimed areas. Revegetation with native species is the most desirable approach, but non-native plants may be used if they meet the requirements of state and federal introduced species statutes and are not listed as noxious weeds.

Coal mines are subject to detailed reclamation planning and revegetation requirements, as are coal refuse disposal sites. As with non-coal mines, a diverse permanent vegetative cover must be established. Introduced species may be used as necessary to achieve the postmining land use plan.

The Pennsylvania Oil and Gas Act provides for protection of natural resources, environmental rights, and the environmental values stated in the Pennsylvania Constitution. The law and regulations require well site restoration and sediment and erosion control measures, but contain no specific provisions regarding revegetation or conservation of biological resources.

Pennsylvania's Land Recycling Program (commonly known as Act Two) establishes alternative cleanup standards for industrial lands for reuse. The program works in conjunction with a "Green Opportunities for Brownfields" program, which is designed to link use of old industrial sites with potential greenways, recreation areas, and watershed protection. For example, a 90-acre wildlife habitat is being created on a PPG Industries parcel in Armstrong County, in connection with reuse of the remainder of the parcel.



Rhodora at Long Pond

SUMMARY

State laws and policies play a critical role in the conservation of biodiversity. There are significant opportunities under current laws and programs for Commonwealth agencies, organizations, local governments, corporations, and citizens to develop and implement a statewide strategy for protecting biodiversity. Understanding where we are is an essential first step in determining where we want to go. Pennsylvania brings many assets to that journey.

Funding for Biodiversity Research and Conservation



Eastern hognose

F

unding for biodiversity research and conservation should address information needs in the context of best management practices, including baseline surveys; basic research on biological and ecological aspects of biodiversity; applied research on methods for management, control, and protection; dependable and persistent monitoring of species, populations, and habitats; methods for accurately assessing management outcomes; and protection of critical habitats.

STATE FUNDING PROGRAMS

The Commonwealth has two major sources of funding for conservation land acquisitions – tipping fees paid by waste haulers to dump trash in Pennsylvania landfills and the real estate transfer tax. Each of these sources is used not only for state land and easement acquisitions, but also to support local and nonprofit acquisitions.

The Keystone Recreation, Park, and Conservation Fund Act (Key 93), passed in 1993, provides funding for acquisition of natural areas and open space, using the proceeds from a portion of state realty transfer tax revenues. Key 93 programs have acquired over 31,000 acres of land in Pennsylvania.

Growing Greener, enacted in December 1999, is the other significant source for conservation funds. The original Growing Greener provisions were slated to provide \$645.9 million over five years with money coming from the General Fund and money redirected from the Recycling and Hazardous Sites Cleanup funds. New funding, earmarked in 2002, will provide an average of \$100 million/year for the next 10 years. Starting in 2004-2005, revenues will be derived entirely from tipping fees on landfilled municipal waste. Growing Greener supports farmland preservation, open space acquisition, watershed improvements, local grant programs, recreation and park facilities, and greenways. Funds are divided among the Department of Conservation and Natural Resources (DCNR), Department of Environmental Protection, Department of Agriculture, and PENNVEST.

Wild Resource Conservation Fund

The major state funding program with a specific focus on research on wild plants and non-game animals is the Wild Resource Conservation Fund (WRCF), established in 1982 by the Wild Resource Conservation Act. Now administered by the Office of Wild Resource Conservation in DCNR, funding from WRCF addresses recommendations from that agency as well as the Pennsylvania Game Commission and Pennsylvania Fish and Boat Commission. Long-term stable funding for WRCF remains as an unaddressed need.

State Program / Agency	Key Aspects of Funding for Biodiversity
Wild Resource Conservation Fund (administered by Office of Wild Resource Conservation, DCNR)	<ul style="list-style-type: none"> Established by the Wild Resource Conservation Act in 1982. Funds research, conservation, and restoration of wild plants and non-game animals and County Natural Areas Inventories. Uses taxpayer-contributed funds, funds from license plate and other sales, and Growing Greener money. Recent grants total \$500,000/year, currently all derived from Growing Greener. Future funding levels uncertain, due to declines in tax check-offs and license sales. Funding addresses recommendations made by DCNR, Pennsylvania Game Commission, and Pennsylvania Fish & Boat Commission.
Community Conservation Partnerships Program (administered by Bureau of Recreation and Conservation, DCNR)	<ul style="list-style-type: none"> Offers nearly \$30 million annually in grants for community recreation, trails, river conservation, critical natural areas, open space, and heritage projects. Uses federal funds, Pennsylvania general funds, Growing Greener, and Keystone Funds. Land Trust Grants program gives priority to habitat for threatened and endangered species.
Department of Environmental Protection	<ul style="list-style-type: none"> Various grant programs with potential impact on biodiversity, including watershed restoration, riparian buffers, mine land restoration, and oil and gas well plugging. Manages Environmental Education Grants Program, supported by environmental fines.
Land Use Planning and Technical Assistance Program (administered by the Department of Community and Economic Development)	<ul style="list-style-type: none"> Offers land use planning assistance. Provides planning grants to local governments, with special preference for multi-municipal and cooperative planning. Manages awards program for Local Government Excellence.
Agricultural Easement Program	<ul style="list-style-type: none"> Provides for purchase of conservation easements in Agricultural Security Areas. May acquire easements on forest lands, but generally eligible only if associated with crop land, grazing, or pasture lands. Easements cover 212,707 acres on 1,764 farms in 51 counties as of December 2001.



PA Biodiversity Partnership

PBP is a voluntary coalition. Individuals interested in more information or supporting biodiversity conservation can contact the Pennsylvania Biodiversity Partnership, 16 Terminal Way, Pittsburgh, PA 15219; 412-481-4100; pbpinfo@pabiodiversity.org. Additional information also is available on PBP's website at www.pabiodiversity.org.

FEDERAL FUNDING PROGRAMS

Federal Program/Agency	Key Aspects of Funding for Biodiversity
Conservation Reserve Program (regular CRP) (U.S. Department of Agriculture)	<ul style="list-style-type: none"> • Pays landowners to convert highly erodible cropland or other environmentally sensitive acreage to native grasses, wildlife plantings, trees, filter strips, or riparian buffers. • 59,587 acres enrolled in Pennsylvania as of mid-2002.
Conservation Reserve Enhancement Program (CREP) (USDA)	<ul style="list-style-type: none"> • Focuses on highly erodible land and streamside buffers. • 54,000 acres enrolled out of a total maximum of 100,400 acres offered as of September 2002.
Environmental Quality Incentives Program (EQIP) (USDA)	<ul style="list-style-type: none"> • Provides technical, financial, and educational assistance to eleven priority areas in Pennsylvania. • 1,089 contracts written with Pennsylvania landowners obligating over \$11 million through mid-2000.
Wildlife Habitat Incentives Program (WHIP) (USDA)	<ul style="list-style-type: none"> • Gives landowners cost-shares to provide habitat for wildlife, endangered species, and fisheries. • Enrollments in Pennsylvania include about 430 landowners, affecting 5,160 acres in 40 counties.
Forestry Incentives Program (USDA)	<ul style="list-style-type: none"> • Offers financial assistance to non-industrial private forest landowners to plant and maintain working forest lands.
Forest Stewardship Program (USDA)	<ul style="list-style-type: none"> • Provides technical assistance to landowners voluntarily seeking to enhance wildlife habitat, protect soil and water quality, increase wood production, and fulfill other multiple use objectives. • Pennsylvania landowners with five acres or more of forest land eligible to participate. • About 2,400 landowners have Forest Stewardship Plans.
Forest Legacy (USDA)	<ul style="list-style-type: none"> • Provides funding to purchase conservation easements on forest land to retain forest and forestall conversion to developed uses. • Pennsylvania applied to participate on a regional basis in 2001.
Partners for Wildlife (U.S. Fish & Wildlife Service)	<ul style="list-style-type: none"> • Provides funding and technical assistance, in cooperation with PA Game Commission, to private landowners for restoration of native wildlife habitat. • About 1,500 Pennsylvania landowners participate, with activities on 5,000 acres of wetlands, 4,000 acres of forest and upland restoration, and 150 miles of riparian buffers and streambank stabilization.
Wildlife Restoration and Conservation Program (U.S. Fish and Wildlife Service)	<ul style="list-style-type: none"> • Federal grants to the states to fulfill the needs of wildlife not met by other sources. • Administered by the PA Game Commission and PA Fish and Boat Commission.
National Park Service	<ul style="list-style-type: none"> • Administers grant programs under the Land and Water Conservation Fund and other programs. • Helps acquire and improve state lands, greenways, trails, and other conservation and recreational infrastructure.
Environmental Protection Agency	<ul style="list-style-type: none"> • Provides funds that support state actions to protect the environment.
Transportation Enhancement Act (TEA-21)	<ul style="list-style-type: none"> • Enhancements include acquisition of scenic easements or scenic sites, wildlife underpasses, rails-to-trails projects, and environmental mitigation to reduce vehicle-caused wildlife mortality while maintaining habitat connectivity. • Pilot program to make transportation and land use connections, which is intended to promote compact development and alternatives to sprawl.

LOCAL GOVERNMENT FUNDING

Local Program/Initiatives	Key Aspects of Funding for Biodiversity
Property Tax and Earned Income Tax	<ul style="list-style-type: none">• Authorizes municipalities to levy property tax or earned income tax for acquiring open space, if approved by the voters.• Used by a few municipalities in rapidly developing areas.
Act 515	<ul style="list-style-type: none">• Allows counties to enter into covenants with owners to maintain land in open space, farm, forest, or water supply uses in exchange for a property assessment that values the land as open space.• Five counties in eastern Pennsylvania participate, with 300,000 acres assessed.
Farmland and Forest Assessment Act (Clean and Green)	<ul style="list-style-type: none">• Property tax relief program.• Allows counties to assess agricultural land, agricultural reserve land, and forest reserve land at current use value rather than market value.• More than 5 million acres in 48 counties currently assessed under Clean and Green.
Bonds	<ul style="list-style-type: none">• Municipalities and other government entities authorized to issue bonds for open space acquisition and conservation easements.• Bonds are sometimes tax-exempt.

PRIVATE FUNDING

In addition to government funding, conservation organizations and land trusts raise their own funds from donors and foundations. Organizations like the Conservation Fund, Heritage Conservancy, The Nature Conservancy, Western Pennsylvania Conservancy, Wildlands Conservancy, and other members of the Pennsylvania Land Trust Association provide substantial benefits to biodiversity conservation by acquiring lands – either for management themselves, or more often, conveyance to the Game Commission, DCNR, or other public entities. Land trusts can often identify lands, put the deal together and arrange financing in a more rapid and nimble fashion than governmental agencies.

Research on Pennsylvania biodiversity is conducted by many private non-profit organizations and individual researchers at academic institutions, utilizing a variety of funding sources, including those previously listed as well as monies internal to the organizations and federal sources such as the National Science Foundation.

Pennsylvania is fortunate in having many foundations that focus at least part of their substantial assets on environmental issues within the state, including the Heinz Endowments, Laurel Foundation, McKenna Foundation, R.K. Mellon Foundation, Claneil Foundation, William Penn Foundation, and others.

SUMMARY

Although there is a diversity of funding sources for biodiversity research and conservation in Pennsylvania, the amount of money available does not come close to meeting the projected needs. For example, in 2001 the Wildlife Restoration and Conservation Program received proposals requesting more than \$7 million for the \$1.5 million earmarked for Pennsylvania. The Pennsylvania Biological Survey estimated in 1992 that at least \$13 million per year was needed for basic research and inventory, education, and habitat acquisition.

In particular, funding to gather information on basic questions such as what plants and animals live in the state, where they live, and their ability to reproduce and thrive is limited. Lack of such fundamental knowledge about biodiversity in the state hampers efforts at conservation.

Conservation of biodiversity is vital to our ecological health, economic vigor, and the quality of life of all citizens. Government alone cannot undertake this task.

Conclusions and Next Steps



What You Can Do

- Get involved in efforts to conserve Pennsylvania's biodiversity.
- Contact the Pennsylvania Biodiversity Partnership (412-481-4100; pbpinfo@pabiodiversity.org) or visit PBP's website at www.pabiodiversity.org.
- Attend regional meetings to assist in development of the Pennsylvania Biodiversity Conservation Plan.
- Participate in community dialogues on conservation issues.
- Adopt best management practices for conserving biodiversity on your own lands.



Biodiversity in Pennsylvania: Snapshot 2002 reveals that despite extensive knowledge about natural resource conservation in Pennsylvania and many activities focused on conserving wildlife and habitats, there is much we don't know about biodiversity in the state. Many gaps need to be filled.

In the face of this imperfect knowledge, one point is clear – sustainable use of our natural resources is critical for maintaining Pennsylvania's economic health, as well as the quality of life of all Pennsylvanians. Even with extensive technological advances and modern conveniences, our survival still depends on natural resources. Basic necessities, such as the air we breathe, drinkable water, and an adequate food supply, as well as medicines, fibers, and building materials are supplied by the other species that share this planet. Conserving biodiversity in Pennsylvania is essential not only for Pennsylvanians, but is also an important linking thread in the global web of life.

Despite the importance of biodiversity and the continuing threats to biological communities, Pennsylvania lacks a statewide strategy for biodiversity conservation. Critical habitats, plants, and animals are being lost every year in the Commonwealth due to development, neglect, and lack of coordination among interested parties.

This snapshot of biodiversity in Pennsylvania in 2002 provides insights that will guide a comprehensive statewide biodiversity conservation plan.

- Although scientists and naturalists have been collecting and studying Pennsylvania plants and animals for more than 250 years, no complete list of species exists.
- At least 150 species have been lost from the state and more than 350 are presently endangered.
- Biodiversity information is scattered among state agencies, museums, universities, conservation organizations, and private individuals, in a wide variety of formats not readily accessible through modern technology.
- Responsibility for monitoring plants, birds, mammals, fish, amphibians, reptiles, mussels, and aquatic insects is divided among state agencies. No government entity has oversight for terrestrial invertebrates – the most diverse group of organisms in the state.
- Many sectors of Pennsylvania's economy impacted by natural resource policies have not been involved in biodiversity conservation initiatives.
- There is still much to learn about the interrelationships among organisms and how we can better manage biodiversity.
- Realistic and measurable goals and assessment strategies are needed to know where problems exist and the degree to which reintroductions, restoration efforts, and management practices actually improve the state's biodiversity resources.
- Past natural history studies and conservation efforts focused on either the eastern or western part of the state, and rarely looked at Pennsylvania as a whole. In addition, most efforts have focused on rare and endangered species with no programs for monitoring all native species.
- We need more information on how to control the invasive species threat and how to predict which plants or animals might become invasive.
- Additional tools are needed to enable more private landowners to voluntarily enhance native biodiversity on their own lands.
- Some educational materials on biodiversity exist, but there is no organized means to augment these materials and extend them to adult audiences.
- Although diverse funding sources exist for research and conservation of Pennsylvania biodiversity, the available money does not come close to meeting the projected needs.

Pennsylvania Biodiversity Partnership

Understanding and conserving the web of life in Pennsylvania demands a comprehensive view. This can only be achieved with the participation of all organizations, agencies, and individuals involved in biodiversity studies or impacted by the loss of biodiversity. To this end, the Pennsylvania Biodiversity Partnership (PBP) was created in 2000 in direct response to a recommendation made by the Pennsylvania 21st Century Environment Commission.

PBP is a broad-based, public-private partnership formed to promote the conservation of native species and their communities. PBP is unique in bringing together – as equal partners –

organizations and individuals with diverse interests and backgrounds. PBP members represent conservation and environmental organizations, government agencies, business and industry, scientists and academic institutions, sportsmen, and private landowners.

PENNSYLVANIA BIODIVERSITY CONSERVATION PLAN

Even though PBP members represent a wide range of backgrounds and opinions, a consensus quickly emerged on the priority of developing a comprehensive statewide plan for conserving Pennsylvania's biodiversity. *Biodiversity in Pennsylvania: Snapshot 2002* summarizes the present state of biodiversity in Pennsylvania. It is the first step in a multi-year process to formulate the Pennsylvania Biodiversity Conservation Plan (BCP).

Phase One focused on a literature-based synthesis of the present status of biodiversity in Pennsylvania, which is summarized in this *Biodiversity in Pennsylvania: Snapshot 2002*. The full reports on which this summary is based are available on PBP's website at www.pabiodiversity.org.

Phase Two will build on this baseline information and concentrate on preparing the Blueprint for the Pennsylvania Biodiversity Conservation Plan. This document will:

- Pinpoint gaps in our knowledge of Pennsylvania's biodiversity.
- Identify ways to fill the gaps and begin the process to achieve this goal.
- Consolidate recommendations on biodiversity from existing reports and strategic plans and begin to formulate additional recommendations.
- Begin to develop criteria by which biodiversity can be objectively measured and to establish baselines against which future trends can be evaluated.
- Provide a blueprint for how to achieve the final Pennsylvania Biodiversity Conservation Plan.

These documents will serve as the focus of regional meetings in Phase Two and Phase Three, with expected completion of the Pennsylvania Biodiversity Conservation Plan in 2005. All Pennsylvanians are welcome to participate in this process.

Pennsylvania Biodiversity Conservation Plan Timetable

Phase	Activities
Phase One Biodiversity in Pennsylvania - Snapshot 2002 2001-2002	<ul style="list-style-type: none"> • Baseline report on present state of biodiversity as we know it. • Research current conditions and information.
Phase Two Blueprint for the Pennsylvania Biodiversity Conservation Plan 2002-2003	<ul style="list-style-type: none"> • Conduct regional meetings of organizations and individuals interested in biodiversity issues. • Pinpoint gaps in our knowledge. • Identify ways to fill gaps and begin the process to achieve this goal. • Continue information gathering. • Consolidate existing recommendations. • Provide a blueprint for achieving the Pennsylvania Biodiversity Conservation Plan.
Phase Three Draft Pennsylvania Biodiversity Conservation Plan 2003-2004	<ul style="list-style-type: none"> • Continue regional public meetings. • Solicit additional recommendations and comments. • Prioritize recommendations. • Continue information gathering.
Phase Four Pennsylvania Biodiversity Conservation Plan 2005	<ul style="list-style-type: none"> • Finalize and publish document. • Partners begin implementation.

Benefits of a Statewide Biodiversity Conservation Plan

- Facilitate interactions among groups concerned with biodiversity.
- Increase cooperation and coordination among government agencies, organizations, business, and individuals involved in biodiversity issues.
- Minimize duplication of efforts among organizations.
- Establish informed priorities for inventory, monitoring, and conservation at a statewide level.
- Develop educational and training materials for managing and enhancing Pennsylvania biodiversity.
- Increase voluntary stewardship of biodiversity and thus avoid the need for additional regulations.
- Increase educational opportunities regarding the impact and importance of biodiversity to our lives and to the ecological and economic health of Pennsylvania

**Sustainable
use of our
natural
resources is
critical for
maintaining
Pennsylvania's
economic
health as well
as the quality
of life of all
Pennsylvanians.**

Appendix

Selected Best Management Practices for Enhancing Biodiversity in Pennsylvania

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**Critical habitats, plants, and animals
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Pennsylvania's Wildlife Action Plan (PA-WAP) PART IIB

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21.1 Location and Condition of Thicket/Shrubland Habitats

Temporal shrublands/thickets are not easily quantified in current inventory and mapping methods. As a result, there is no accurate estimate for the amount of acreage in temporal thicket habitats. Furthermore, early-successional habitats are defined differently by different people. Wildlife that inhabits a second-year field as compared to an overgrown orchard or 10-year-old forest are quite different. Thus, it is important to keep definitions in mind. In 1989, the U.S. Department of Agriculture forest inventory (Alerich 1993) found that about 15 percent of Pennsylvania's timberland (three million acres) was in the sapling stage, or young forest.

In Pennsylvania, these early-successional forests are in decline (McWilliams et al. 1995). From 1978 to 2002, the total acreage in Pennsylvania forestland remained stable, but the proportion in early-successional stages (seedling, sapling and non-stocked) declined from 20.7 percent to 11.8 percent (Alerich 1993, McWilliams et al. 1995). While the aging of trees is the primary factor in loss of key habitats, factors such as highway and urban development, intensification of agriculture, and slowing farm abandonment all contributed to decreasing quantity and quality of optimum thicket habitats.

Naturally-Occurring Barrens

Pennsylvania has four major barrens community complexes (including ridgetop acidic barrens, mesic-till barrens, serpentine barrens, and shale barrens) and several minor shrubland community types (Table 21.1). Most barrens communities are restricted to xeric-shallow soils, with the exception of mesic-till barrens found on the Pocono Plateau.

Table 21.1: Barrens community types found in Pennsylvania. For detailed descriptions, readers are referred to the following sections of Appendix 4:

Pennsylvania Natural Community Types	Appendix 4, pages:
SHRUBLAND BARRENS	35-39
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The mesic-till barrens, located on the southern edge of the Pocono Plateau in northeastern Pennsylvania, include the largest areas of barrens vegetation in Pennsylvania. They are dominated by scrub oak, sheep laurel, lowbush blueberries and

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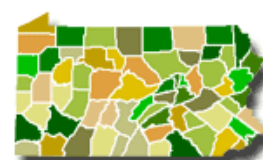
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[Watchable Wildlife](#)

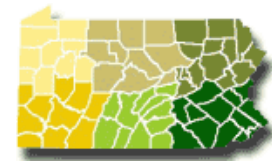


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rhodora, and have a shrub-savanna appearance with an open overstory of pitch pine (Latham et al. 1996). Unlike many of the barrens in eastern North America, which typically grow in excessively drained soils or shallow-to-bedrock substrates, these barrens grow in mesic soils forming in glacial till. Some plants characterized as wetland indicator species comprise a significant portion of the barrens, along with other more xeric vegetation typical of barrens communities (Latham et al. 1996). These barrens contain the highest concentration of globally-rare plant and animal species in Pennsylvania (Davis et al. 1991).

[County Information](#)



[Regional Information](#)

The ridgetop acidic barrens community consists primarily of scrub oak barrens, pitch pine-scrub oak barrens, and some heath barrens. Scrub oak is the dominant canopy species with pitch pine, black gum, chestnut oak, and sassafras occurring in localized patches and infrequently scattered throughout. The barrens are primarily restricted to the highest, most-exposed portions of the ridge and are surrounded by slopes and drainages with mixed hardwood forests. Known locations of ridgetop acidic barrens occur in Lackawanna County (Moosic Mountain barrens), Luzerne County (Arbutus Peak barrens), Centre County (Scotia barrens), and Schuylkill County. The Moosic Mountain barrens was recognized in the Lackawanna Natural Area Inventory as one of the largest barrens complexes in Pennsylvania and graded good to excellent in quality. The Scotia barrens are a pitch pine-scrub oak barrens system that lies in a region of uncharacteristic temperature ranges which, in normal conditions, can produce a month of subzero minimum temperatures per year and frost in midsummer (ClearWater News 2004). According to the Centre County Natural Heritage Inventory, the unique topography makes it an area of exceptional significance from a biodiversity standpoint. WAP-priority species associated with ridgetop acidic barrens complex include Allegheny woodrat, timber rattlesnake, eastern hognose snake, northern copperhead, and Appalachian cottontail.

The serpentine barrens are located along the Pennsylvania and Maryland border in Lancaster and Chester counties. There are a total of eight sites, seven in Pennsylvania, totaling 2,100 acres, the largest expanse of serpentine vegetation in eastern temperate North America. These barrens represent those areas where serpentinite bedrock is either exposed or is near enough to the surface to influence soil properties. A site conservation plan for the serpentine barrens conducted by the Pennsylvania Science Office (PSO) of The Nature Conservancy (TNC), as well as TNC, identified the serpentine vegetation as the conservation target, which is defined as any assemblage of plants with a large proportion of species having high regional fidelity to soils weathered from ultramafic rocks (Latham 2000.) According to PSO, these barrens are ranked as highly significant to significant and contain many rare plant and animal species.

The shale barrens are located in southcentral Pennsylvania, specifically Fulton, Bedford and Huntingdon counties. A shale barren is a steep south-facing slope where the bedrock is composed of shale and the rocky, dark, shale soils can reach temperatures of 140-degrees F when the sun is shining full strength. Despite the dry living conditions, many species have become adapted to this habitat including the Pennsylvania shale barrens evening primrose, cat's paw ragwort, fence lizards and many rare moth species. Shale barrens are only found from southern Pennsylvania through West Virginia to southern Virginia thereby leaving many of the species dependent on them listed as threatened and endangered.

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Pennsylvania Game Commission - State Wildlife Management Agency

Pennsylvania's Wildlife Action Plan

4.2. Pennsylvania's Valuable Wild Resources



William Penn

"The air is sweet and clear, and the heavens serene . . . Of living creatures, fish, fowl, and the beasts of the wood, here are divers sorts . . ."

- William Penn, 1683

Pennsylvania is blessed with a rich diversity of fish, wildlife, and plants. More than 10,000 species of plants and animals are known to exist in the Commonwealth. As inventory efforts continue, it is estimated that the total number of known plants and animals in Pennsylvania will reach 20,000 species. This diversity of species contributes to Pennsylvanians' well being by providing important recreational, economic, and biological benefits to the Commonwealth.

Recreational Values

While the number of hunters and anglers has been declining across the country for several decades, the number of people involved in watchable wildlife activities like bird feeding and wildlife photography has exploded. Birdwatching is the fastest-growing outdoor pastime in the country, growing 232 percent between 1983 and 2001, according to the latest National Survey on Recreation and the Environment.

This national trend is echoed in Pennsylvania. Pennsylvanians rank first in the nation in time spent hunting and third in time spent wildlife watching. In 2001 (the most recent year for which data exists), about 1 million Pennsylvanians hunted, more than 1.2 million fished, and 3.7 million participated in nonconsumptive wildlife recreation, such as viewing, feeding, and photographing wildlife. More than one in four Pennsylvanians actively participates in watchable wildlife recreation. When the number of resident and visiting participants are combined, those who enjoy wildlife viewing in Pennsylvania outnumber the combined populations of Maine and West Virginia!



Wood Turtle
Hal Korber

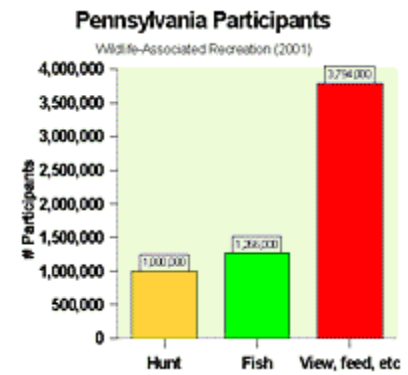
A recreation participation survey conducted in 1990 revealed that Pennsylvanians spent more time birdwatching and wildlife watching (23.9 activity days per capita) than any other outdoor recreation activity except walking and jogging. In addition, hiking/nature walks showed a greater increase in activity days per participant and a greater increase in activity days per capita over the past 20 years than all other outdoor activities.

Watchable Wildlife Recreation- Quick Facts!

(Source: Southwick Associates, Inc.)

- More than one Pennsylvanian in four actively participates in watchable wildlife recreation, such as viewing, feeding, and photographing wildlife. The state ranks third nationally, behind only California and New York, in the number of people participating in watchable wildlife recreation.

- Those who enjoy wildlife viewing in Pennsylvania, including residents and visitors, number more than the combined populations of Maine and West Virginia.
- A live webcam showing a peregrine falcon nest on the Rachel Carson Office Building in Harrisburg registered 54 million hits in 2001, making it one of the most popular nature sites on the World Wide Web.
- The number of out-of-state residents who visited Pennsylvania in 2001 to view wildlife outnumbered the residents of Allentown nearly 3 to 1.



Economic Values

With nearly six million Pennsylvanians (nearly 50 percent of the adult population) using and enjoying the outdoors, this activity makes a significant contribution to the Commonwealth's economy. Wildlife-related recreation is an economic heavyweight in Pennsylvania - hunting, fishing, and wildlife watching combined generates nearly \$6 billion in total economic impact each year. In 2001, economic activity associated with hunting and fishing totaled more than \$2.2 billion and \$1.6 billion respectively, while nonconsumptive wildlife recreation (viewing, feeding, and photographing wildlife) generated nearly \$2 billion in economic activity. Altogether, wildlife-associated recreation supported more than 50,000 jobs and contributed \$190 million to the Commonwealth's General Fund via state sales and income tax.



Elk Watching
Hal Korber/PGC

While they may not buy rifles or fishing rods, Pennsylvania's wildlife viewers purchase varied equipment to enjoy their pursuits, including: bird seed, feeders, field guides, binoculars, boats, gas, lodging and meals. In fact, the total economic impact of watchable wildlife recreation in Pennsylvania is \$1.98 billion - more than the annual value of dairy products, our state's top agricultural commodity.

Total economic effect of nonconsumptive bird and waterfowl recreation alone is estimated at more than \$450 million per year in Pennsylvania. Like other forms of outdoor recreation, nonconsumptive wildlife recreation creates significant benefits for communities surrounding the recreation site. As an example, more than 50,000 birdwatchers visit Hawk Mountain Sanctuary in Berks county each year and spend roughly \$3 million in surrounding communities. These birdwatching expenditures are an important source of revenue for more than 200 local motels, bed and breakfasts, campgrounds, restaurants, gas stations, and gift shops.

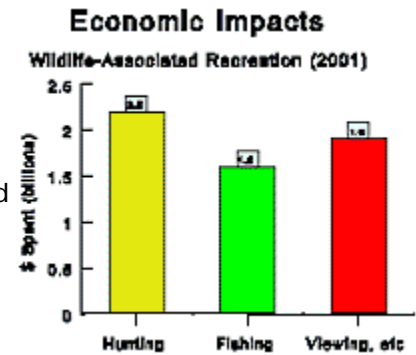
Clearly, wildlife-associated recreation is an important economic engine in Pennsylvania. Wildlife-associated recreation also serves as a low-cost, high-benefit sector in Pennsylvania's economy. This is especially true when one considers that the Fish & Boat Commission and the Game Commission - the agencies responsible for managing fish and wildlife - do not draw from the state's General Fund when managing our wild resources.

Watchable Wildlife Economics - Quick Facts!

(Source: Southwick Associates, Inc.)

- In 2001, watchable wildlife recreation generated twice the value of all cattle and beef produced by Pennsylvania's farms, and three times the total spent nationally by moviegoers to see 2001's top-grossing film, "Harry Potter and the Sorcerer's Stone."

- Watchable wildlife generated \$70 million in state sales and income taxes, \$87 million in federal taxes, and \$962 million in retail sales, (including \$96 million for bird seed and \$16 million for food, travel and lodging) in 2001.
- Watchable wildlife recreation supports almost 19,000 full- and part-time jobs with wages of more than \$509 million. It supports more workers in Pennsylvania than are employed nationally by Sunoco, a PA-based Fortune 500 company.
- Wildlife viewing expenditures in 2001 in Pennsylvania were nearly a third greater than all of the money spent nationally on skiing and snow-boarding equipment.
- Watchable wildlife recreation overwhelmingly benefits rural communities, often at times of the year when other income sources are low.



Biological Values

Pennsylvania's natural communities perform vital ecological functions such as photosynthesis, climate regulation, nutrient cycling, erosion control, soil formation, pest control, pollination, and water purification and storage. Through these processes, Pennsylvania's wild species contribute to the maintenance of ecosystems that support human life.

In the interrelated web of Pennsylvania's wild resources, obscure species are the foundation upon which well-known, charismatic species rely: meadow voles feed birds of prey and furbearers; countless terrestrial insects support wild turkeys, grouse, pheasants, and songbirds; aquatic insects form the mainstay of trout populations; "forage" fish feed sportfish, and; diverse plant communities support a host of herbivores from chipmunks to elk. Across Pennsylvania, the survival of game birds and mammals, sportfish, and "showy" wildlife - that collectively support a \$5.8 billion annual industry - is dependent upon the continued well-being of some of our most obscure, least understood species.

Unfortunately, habitat changes that have occurred since the settlement of Pennsylvania have taken their toll on the Commonwealth's fish and wildlife. During the past 300 years, 156 plant and animal species have disappeared from Pennsylvania, and another 351 species have become threatened or endangered. Thus, 507 species (13 percent of Pennsylvania's plants and animals) are threatened, endangered, extirpated, or extinct. Although Pennsylvania still enjoys a rich diversity of fish and wildlife, many species have already been lost and many more are in jeopardy (Table 4-1).

Because fish and wildlife are so valuable to humans in so many ways, declines in numerous populations are a reason for concern. Some wildlife, such as the northern bobwhite quail, have declined so rapidly that they are in danger of disappearing entirely. These Immediate Concern species require immediate conservation action. Others, including the wood thrush, remain widespread but deserve attention to prevent continued decreases. The sobering state of the Commonwealth today is that most fish and wildlife species currently enjoying population increases are exotic invaders from other countries, or species that are undergoing population explosions due to a lack of predators or other population control mechanisms.

The causes of population declines among fish and wildlife are numerous; but the loss, modification, degradation, and fragmentation of habitat almost always play a major role. Threats to habitats come primarily from intensified land-use practices in agricultural and forested regions and from other impacts associated with human population growth.

Because fish and wildlife habitats are directly affected by human use of the land, the health of Pennsylvania's fish and wildlife is in our hands. We have a stewardship responsibility for

maintaining healthy populations of still-common species in addition to preventing extinctions. For though our understanding of the wild systems of Pennsylvania is greater now than it ever has been, no one knows what a continued loss of species would mean for the Commonwealth's interrelated web of life.



Aldo Leopold

"The outstanding scientific discovery of the twentieth century is not television, or radio, but rather the complexity of the land organism. Only those who know the most about it can appreciate how little is known about it. The last word in ignorance is the man who says of an animal or plant "what good is it?" If the land mechanism as a whole is good, then every part is good, whether we understand it or not. If the biota, in the course of aeons, has built something we like but do not understand, then who but a fool would discard seemingly useless parts? To keep every cog and wheel is the first precaution of intelligent tinkering.

- Aldo Leopold, Essays on Conservation from Round River

Table 4-1. Percent of Pennsylvania's native species that have been lost from the Commonwealth or are in danger of becoming so.

(Source: PA Biological Survey)

Taxon	Found Wild in Pennsylvania*	Threatened or Endangered	I
Mammals	73	6	
Birds	394/186**	16	
Amphibians	36	4	
Reptiles	37	5	
Fish	217/160**	43	
Invertebrates	11,722??	144	
Mussels	165	18	

* Totals include native and non-native species.

**The higher number includes species that visit Pennsylvania but are not year round residents.

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Pennsylvania Biodiversity Partnership

What Is Biodiversity

What is Biodiversity?

Biodiversity is the variety of species, their genetic make-up, and the natural communities in which they occur. It includes all of the native plants and animals in Pennsylvania and the processes that sustain life on Earth. Pennsylvania is home to over 25,000 different species of organisms, and of this total, over 800 are considered to be rare, threatened, or endangered. For many groups of organisms, such as insects, fungi, and algae, very little is known about them - not even what species occur in Pennsylvania! The need to understand the state's rich natural resources has never been more critical.

The term ecosystem is defined as a community of living organisms combined with their associated physical environment. It is our "home system" that makes life possible. Ecosystems are the full tapestry of nature that support life and they also provide valuable services.

- Wetland ecosystems filter out toxins, clean the water, and control floods.
- Estuaries act as marine-life nurseries.
- Forest ecosystems supply fresh water, provide oxygen, control erosion, and remove carbon from the atmosphere.

Many species, working together, are needed to provide these critical services. The loss of biodiversity reduces nature's ability to perform these functions. As greater fluctuations occur, ecosystems as a whole become less stable. Instability causes ecosystems to be more vulnerable to extreme conditions and may also decrease productivity.

Why is Biodiversity Important?

While the term "biodiversity" may not be well known or understood, the ecological services provided by biodiversity are vital to everyday life. Not a day, hour, or even second goes by that we do not depend on biodiversity for survival.

- The air we breathe is a product of photosynthesis by green plants.
- Insects, worms, bacteria, and other tiny organisms break down wastes and aid in the decomposition of dead plants and animals to enrich soils.
- More than 90 percent of the calories consumed by people worldwide are produced from 80 plant species.
- Almost 30 percent of medicines are developed from plants and animals, and many more are derived from these sources.

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What is an Invasive Plant?

"Invasive plant" is a name for a species that has become a weed pest, a plant which grows aggressively, spreads, and displaces other plants. Invasive plants tend to appear on disturbed ground, and the most aggressive can actually invade existing ecosystems. Invasive plants are generally undesirable because they are difficult to control, can escape from cultivation, and can dominate whole areas. In short, invasive plant infestations can be extremely expensive to control, as well as environmentally destructive.



A small number of invasives are "native," meaning they occurred in Pennsylvania before settlement by Europeans but became aggressive after the landscape was altered. However, most invasive plants arrived from other continents and are often referred to as "exotic," "alien," introduced," or "nonnative" invasives. An aggressive plant freed from its environmental, pest, and disease limits, can become an invader of other ecosystems.

Characteristics of Invasive Plants

Invasive plants are noted for their ability to grow and spread aggressively. Invasive plants can be trees, shrubs, vines, grasses, or flowers, and they can reproduce rapidly by roots, seeds, shoots, or all three. Invasive plants tend to:

- not be native to North America;
- spread, reproducing by roots or shoots;
- mature quickly;
- if spread by seed, produce numerous seeds that disperse and sprout easily;
- be generalists that can grow in many different conditions;
- and be exploiters and colonizers of disturbed ground.

Impact of Invasive Plants

The primary reason to **not** landscape with invasives is that they are degrading our native environments. In fact, second only to habitat loss, invasives are a major factor in the decline of native plants. Plants like Kudzu, Purple Loosestrife, and Garlic Mustard are displacing native plants and degrading habitat for native insects, birds, and animals. Endangered, rare, and threatened native species of plant and animals are especially at risk because they often occur in such small populations that make them particularly vulnerable.

Another reason to avoid invasives is that invasive plants, even when grown in a cultivated yard, can spread, escape, and cause landscape maintenance weeding problems for years to come. In urban and suburban areas there is a good chance that the worst weeds on your property are escaped plants, like Japanese Honeysuckle, Multiflora Rose, Japanese Knotweed, and Oriental Bittersweet. In yards, gardens, fields, and parks these plants are very expensive to control.

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This series of single page fact sheets is designed to help recreational enthusiasts learn how they can play a critical role in minimizing the spread of invasive species while participating in recreational activities.

We encourage you to reprint these fact sheets in your newsletters, magazines, and other publications. You may also include them on your organization's website, as long as you credit DCNR.

The following files are in Adobe PDF format. If you need the free Adobe Reader, click the icon below.



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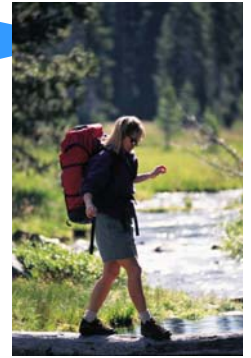
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More information on invasive species can be found on the [Invasive Plants in Pennsylvania page](#).



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What Hikers and Backpackers Need To Know!



Invasive species are taking over parks and natural areas throughout Pennsylvania, making hiking and backpacking difficult and damaging valuable habitat. Luckily hikers can play a critical role in slowing the spread of invasives.

“Invasive species” are non-native plants and animals that can cause harm to the economy, environment, and/or human health.

Invasive plants tend to grow quickly and thickly,

potentially blocking trails. This makes it more difficult for people to hike and backpack.

Mile-a-minute, for example, is a vine that can grow up to a foot per day! It can quickly make trails impassable with its painful spines (*see photo below*).

Invasive species are also a concern to hikers and backpackers because they can ruin the beauty of Pennsylvania landscapes and lower biodiversity (the variety

of living things in an area). We need biodiversity to maintain healthy habitats.

Plus it's simply more interesting and exciting to hike and backpack through a landscape full of different shrubs, trees, flowers, and grasses, rather than through a boring field of the same invasive plant. But that is exactly what could happen if an invasive species appears... all other species, including wildlife, may be chased out or killed!



Mile-a-minute vine

- Know how to identify some of the more common invasive species in your area, so you can avoid hiking through them. Visit www.dcnr.state.pa.us/forestry/invasivetutorial/index.htm to learn more.

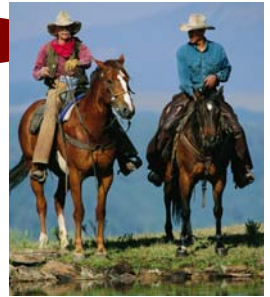
Make A Difference!

Now that you know why invasive species are a concern, what can you do to help minimize their spread? Luckily there are many small, easy steps you can take to keep invasives in check.

- Clean clothing, shoes, pets, backpacks and other equipment before going to a new area to remove hitch-hiking seeds and plant parts (bag the dirt and seeds and place in the trash).
- Don't move firewood! Buy it locally. This will prevent dangerous pest insects like emerald ash borer from arriving in PA.
- Volunteer to help prevent and control invasive species. Contact your local state park/forest office, conservation district, watershed group, or hiking club to get involved.



What Horseback Riders Need To Know!



Invasive species are taking over parks and natural areas throughout Pennsylvania, making horseback riding and the use of pack animals difficult, and also damaging valuable habitat. Luckily riders can play a critical role in slowing the spread of invasives.

“Invasive species” are non-native plants, animals, and pathogens that can cause harm to the economy, environment, and/or human health.

Invasive plants tend to grow quickly and thickly, potentially blocking trails. This makes it more difficult for people to horseback ride and enjoy the outdoors.

Mile-a-minute, for example, is a vine that can grow up to a foot per day! It can quickly make trails impassable with its painful spines (*see photo below*).

Invasive species are also a concern to riders because they can ruin the beauty of Pennsylvania landscapes and

lower biodiversity (the variety of living things in an area). We need biodiversity to maintain healthy habitats.

Plus it's simply more interesting and exciting to ride through a landscape full of different shrubs, trees, flowers, and grasses, rather than through a boring field of the same invasive plant. But that is exactly what could happen if an invasive species appears... all other species, including wildlife, may be chased out or killed!



Make A Difference!

Now that you know why invasive species are a concern, what can you do to help minimize their spread? Luckily there are many small, easy steps you can take to keep invasives in check.

- Know how to identify some of the common invasives in your area, so you can avoid riding through them. Visit www.dcnr.state.pa.us/forestry/invasivetutorial/index.htm to learn more.
- Don't move firewood! Buy it locally. This will keep out invasive insects like emerald ash borer.
- Volunteer to help prevent and control invasive species. Contact your local state park/forest office, conservation district, watershed group, or equestrian club to get involved.
- Stick to designated roads and trails instead of blazing your own.
- Use proper mane and hoof grooming techniques to remove hitch-hiking seeds and plant parts before going to a new area. Also clean off clothing, shoes, packs, and equipment. Bag any dirt, seeds, and hair and properly dispose of this in the trash.



What ATV Riders Need To Know!

Invasive species are taking over parks and natural areas throughout Pennsylvania, making ATV riding difficult and damaging valuable habitat. Luckily riders can play a critical role in slowing the spread of invasives.

“Invasive species” are non-native plants and animals that can cause harm to the economy, environment, and/or human health.

Invasive plants tend to grow quickly and thickly, potentially blocking trails.

This makes it more difficult for people to ride ATVs and enjoy other recreational opportunities.

Mile-a-minute, for example, is a vine that can grow up to a foot per day! It can quickly make trails impassable with its painful spines (*see photo below*).

Invasive species are also a concern to riders because they can ruin the beauty of Pennsylvania landscapes and lower biodiversity (the variety of living things in an area).



We need biodiversity to maintain healthy habitats.

Plus it's simply more interesting and exciting to ride through a landscape full of different shrubs, trees, flowers, and grasses, rather than through a boring field of the same invasive plant. But that is exactly what could happen if an invasive species appears... all other species, including wildlife, may be chased out or killed!



Mile-a-minute vine

- Know how to identify some of the more common invasive species in your area, so you can avoid riding through them. Visit www.dcnr.state.pa.us/forestry/invasivetutorial/index.htm to learn more.

- To avoid disturbing soil, which can spread invasives, stick to designated trails instead of blazing your own.
- Clean off clothing, shoes, and vehicles before leaving an area. Bag any dirt, seeds, and other plant parts. Dispose of this in the trash.

- Volunteer to help prevent and control invasive species. Contact your local state park /forest office, conservation district, or ATV club to get involved.

Make A Difference!

Now that you know why invasive species are a concern, what can you do to help minimize their spread? Luckily there are many small, easy steps you can take to keep invasives in check.



What Bikers Need To Know!

Invasive species are taking over parks and natural areas throughout Pennsylvania, making it more difficult to ride bikes, and damaging valuable habitat. Luckily bikers can play a critical role in slowing the spread of invasives.

“Invasive species” are non-native plants, animals, and pathogens that can cause harm to the economy, environment, and/or human health.

Invasive plants tend to grow quickly and thickly,

potentially blocking trails. This creates a challenge for those that maintain trails, and makes it more difficult for people to ride bikes and enjoy the outdoors.

Mile-a-minute, for example, is a vine that can grow up to a foot per day! It can quickly make trails impassable with its painful spines (*see photo below*).

Invasive species are also a concern to bikers because they can ruin the beauty of Pennsylvania landscapes and lower biodiversity (the

variety of living things in an area). We need biodiversity to maintain healthy habitats.

Plus it's simply more interesting and exciting to ride through a landscape full of different shrubs, trees, flowers, and grasses, rather than through a boring field of the same invasive plant. But that is exactly what could happen if an invasive species appears... all other species, including wildlife, may be chased out or killed!



Mile-a-minute vine

- Know how to identify some of the more common invasive species in your area, so you can avoid riding through them. Visit www.dcnr.state.pa.us/forestry/invasivetutorial/index.htm to learn more.
- Minimize stream crossings to prevent the erosion of stream banks.
- To avoid disturbing soil, which can spread invasives, stick to designated trails.
- Clean off bike tires, clothing, shoes, and other equipment before going to a new area. Bag any dirt, seeds, and other plant parts and properly dispose of this in the trash.
- Volunteer to help prevent and control invasive species. Contact your local state park/forest office, conservation district, watershed group, or bike club to get involved.



What Birders Need To Know!

Invasive species are taking over parks and natural areas throughout Pennsylvania, making birding difficult and damaging valuable habitat. Luckily birders can play a critical role in slowing the spread of invasives.

“Invasive species” are non-native plants, animals, and pathogens that can cause harm to the economy, environment, and/or human health.

Invasive plants tend to grow quickly and thickly, potentially blocking trails.

This makes it more difficult for people to bird watch and enjoy other recreational opportunities.

Mile-a-minute, for example, is a vine that can grow up to a foot per day! It can quickly make trails impassable with its painful spines (*see photo below*).

Invasive species are also a concern to birders because they can ruin the beauty of Pennsylvania landscapes and lower biodiversity (the variety of living things in an area).

We need biodiversity to maintain healthy habitats. Plus it's simply more interesting and exciting to bird watch in a landscape full of different shrubs, trees, flowers, and grasses, rather than through a boring field of the same invasive plant. But that is exactly what could happen if an invasive species appears... all other species, including birds and the insects they eat, may be chased out or killed!



Mile-a-minute vine

Make A Difference!

Now that you know why invasive species are a concern, what can you do to help minimize their spread? Luckily there are many small, easy steps you can take to keep invasives in check.

- Know how to identify some of the more common invasive species in your area, so you can avoid walking through them. Visit www.dcnr.state.pa.us/forestry/invasivetutorial/index.htm to learn more.
- Monitor nest boxes for invasive starlings and house sparrows.
- Stick to designated trails instead of blazing your own.
- Choose native plants to attract birds to your yard.
- Clean off clothing, shoes, and equipment before going to a new area. Bag any dirt, seeds, and other plant parts and dispose of this in the trash.
- Volunteer to help prevent and control invasive species. Contact your local state park/forest office, conservation district, watershed group, or birding club to get involved.





What Boaters Need To Know!

Invasive species are taking over lakes, streams, and other natural areas throughout Pennsylvania, making boating, canoeing, and kayaking difficult, and also damaging valuable habitat. Luckily boaters can play a critical role in slowing the spread of invasive species.

“Invasive species” are non-native plants, animals, and pathogens that can cause harm to the economy, environment, and/or human health. Invasives can make it difficult and dangerous for

people to boat and enjoy other recreational opportunities.

For instance, invasive plants like hydrilla tend to grow quickly and thickly, blocking waterways and access trails. Invasive animals like zebra mussels (*see photo below*) can build-up on boat hulls and clog motors, making them overheat.

Invasive species are also a concern to boaters because they can ruin the beauty of Pennsylvania landscapes and

lower biodiversity (the variety of living things in an area). We need biodiversity to maintain healthy habitats.

Plus it's simply more interesting to boat in a water-body surrounded by different vegetation, rather than one with the same invasive plant everywhere. But that is exactly what could happen if an invasive species appears: all other species, including fish and waterfowl, may be chased out or killed!



Zebra Mussels

Make A Difference!

Now that you know why invasive species are a concern, what can you do to help minimize their spread? Luckily there are many small, easy steps you can take to keep invasive hitchhikers in check.

- Know how to identify some of the more common invasive plant species in your area, so you can avoid walking and boating through them. Visit www.dcnr.state.pa.us/forestry/invasivetutorial/index.htm to learn more.
- Don't transfer bilge water to other water-bodies.
- Remove any visible plant parts, mud, and animals from boats and equipment and leave them at the site.
- You can't always see aquatic invasives, but they might be there. And some can survive for days out of water. So always wash boats with a high-pressure spray or hot water, and dry them off, before going to a new water body.
- Don't dump leftover bait into or near the water. It might survive and take over.
- Volunteer to help prevent and control invasive species. Contact your local state park/forest office, conservation district, watershed group, or boating club to get involved.



What Fishermen Need To Know!



Invasive species are taking over rivers, lakes, and other natural areas throughout Pennsylvania, making fishing and boating difficult and damaging valuable habitat. Luckily fishermen can play a critical role in slowing the spread of invasives.

“Invasive species” are non-native plants, animals, and pathogens that can cause harm to the economy, environment, and/or human health.

Invasives can make it difficult for people to fish and enjoy

other recreational opportunities. For instance, invasive animals like the zebra mussel (*see photo below*) can consume most of the plankton that supports fish and other aquatic life. These mussels also absorb a lot of water-borne pollutants, so that if a person eats a fish that has eaten many zebra mussels, they are also consuming that pollution!

Invasive species are also a concern to fishermen because they can ruin the beauty of Pennsylvania

landscapes and lower biodiversity (the variety of living things in an area). We need biodiversity to maintain healthy habitats.

Plus it's simply more interesting to fish in a water body full of different plants and animals, rather than just a few. But that is exactly what could happen if an invasive species appears... all other species, including fish and the insects they eat, may be chased out or killed!



Zebra Mussels

Make A Difference!

Now that you know why invasive species are a concern, what can you do to help minimize their spread? Luckily there are many small, easy steps you can take to keep invasives in check.

- Know how to identify some of the invasive plants in your area, so you can avoid walking and fishing near them. Visit www.dcnr.state.pa.us/forestry/invasivetutorial/index.htm to learn more.
- For more information on aquatic invasive species and how to prevent their spread, visit www.protectyourwaters.net.
- Remove any visible plant and animal parts from fishing equipment and leave it on-site.
- You can't always see aquatic invasives, but they might be there. And some can survive for days out of water. So always wash boats with a high-pressure spray or hot water, and dry it off, before going to a new water body.
- Don't dump leftover bait into or near the water, or it might survive and take over.
- Volunteer to help prevent and control invasive species. Contact your local state park/forest office, watershed group, or fishing club to get involved.
- Don't transfer bilge water to other water bodies.



What Hunters Need To Know!

Invasive species are taking over parks and natural areas throughout Pennsylvania, making hunting difficult and damaging valuable habitat. Luckily hunters can play a critical role in slowing the spread of invasives.

“Invasive species” are non-native plants, animals, and pathogens that can cause harm to the economy, environment, and/or human health.

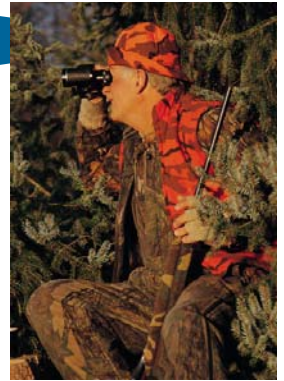
Invasive plants tend to grow quickly and thickly, potentially blocking trails.

This makes it more difficult for people to hunt and enjoy the outdoors.

Mile-a-minute, for example, is a vine that can grow up to a foot per day! It can quickly make trails impassable with its painful spines. (see photo below).

Invasive species are also a concern because they can ruin the beauty of Pennsylvania landscapes and lower biodiversity (the variety of living things in an area). We need biodiversity to , maintain healthy habitats.

Plus it's simply more interesting and exciting to hunt in a landscape full of different shrubs, trees, flowers, and grasses, rather than in a boring field of the same invasive plant. But that is exactly what could happen if an invasive species appears... all other species, including wildlife, may be chased out or killed!



Mile-a-minute vine

Make A Difference!

Now that you know why invasive species are a concern, what can you do to help minimize their spread? Luckily there are many small, easy steps you can take to keep invasives in check.

- Know how to identify some of the common invasive species in your area. Visit www.dcnr.state.pa.us/forestry/invasivetutorial/index.htm to learn more.
- To stop the spread of invasives, try not to walk through patches of these plants.
- Clean off clothing, shoes, and equipment before leaving an area. Bag any dirt, seeds, and other plant parts and properly dispose of this in the trash.
- Don't move firewood! Buy it locally. This will keep destructive invasive insects like emerald ash borer out of Pennsylvania.
- Volunteer to help prevent and control invasive species. Contact your local state park/forest office, conservation district, watershed group, or hunting club to get involved.



What Wildlife Watchers Need to Know!



Invasive species are taking over parks and natural areas throughout Pennsylvania, making wildlife watching difficult and damaging valuable habitat. Luckily wildlife watchers can play a critical role in slowing the spread of invasives.

“Invasive species” are non-native plants, animals, and pathogens that can cause harm to the economy, environment, and/or human health.

Invasive plants tend to grow

quickly and thickly, potentially blocking trails. This makes it more difficult for people to watch wildlife and enjoy the outdoors.

Mile-a-minute, for example, is a vine that can grow up to a foot per day! It can quickly make trails impassable with its painful spines. (*see photo below*).

Invasive species are also a concern to wildlife watchers because they can ruin the beauty of Pennsylvania landscapes and lower biodiversity

(the variety of living things in an area). We need biodiversity to maintain healthy habitats.

Plus it’s simply more interesting and exciting to watch wildlife in a landscape full of different shrubs, trees, flowers, and grasses, rather than in a boring field of the same invasive plant. But that is exactly what could happen if an invasive species appears... all other species may be chased out or killed!



Make A Difference!

Now that you know why invasive species are a concern, what can you do to help minimize their spread? Luckily there are many small, easy steps you can take to keep invasives in check.

Mile-a-Minute Vine

- Know how to identify some of the invasives in your area, so you can avoid walking through them. Visit www.dcnr.state.pa.us/forestry/invasivetutorial/index.htm to learn more.
- To attract wildlife to your yard, choose from a variety of native plants.
- To avoid disturbing soil, which can spread invasives, stick to designated trails instead of blazing your own.
- Clean off clothing, shoes, and equipment before leaving an area. Bag any dirt, seeds, and other plant parts and properly dispose of this in the trash.
- Volunteer to help prevent and control invasive species. Contact your local state park/forest office, conservation district, watershed group, or wildlife club to get involved.



Commonwealth of Pennsylvania
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What Trail Maintainers Need To Know!



Invasive species are taking over parks and natural areas throughout Pennsylvania, making recreation difficult and damaging valuable habitat. Luckily trail maintainers can play a critical role in slowing the spread of invasives.

“Invasive species” are non-native plants and animals that can cause harm to the economy, environment, and/or human health.

Invasive plants tend to grow quickly and thickly, potentially blocking trails.

This makes it more difficult for people to enjoy recreational opportunities.

Mile-a-minute, for example, is a vine that can grow up to a foot per day! It can quickly make trails impassable with its painful spines. (see *photo below*).

Invasive species are also a concern because they can ruin the beauty of Pennsylvania landscapes and lower biodiversity (the variety of living things in an area).

We need biodiversity to maintain healthy habitats. Plus it's simply more interesting and exciting to be in a landscape full of different shrubs, trees, flowers, and grasses, rather than in a boring field of the same invasive plant. But that is exactly what could happen if an invasive species appears... all other species, including wildlife, may be chased out or killed!



Make A Difference!

Now that you know why invasive species are a concern, what can you do to help minimize their spread? Luckily there are many small, easy steps you can take to keep invasives in check.

- Know how to identify and control some of the invasives in your area, so you can remove them while their population is small. Visit www.dcnr.state.pa.us/forestry/invasivetutorial/index.htm for more information.
- Don't create new trails through known or suspected infestations.
- Clean off clothing, shoes, equipment, and vehicles before leaving an area. Bag any dirt, seeds, and other plant parts and properly dispose of this in the trash.
- Use weed-free mulch like straw or wood chips, not hay, which can be full of weed seeds.
- Choose native plants for use along the trail.
- If you need volunteers to help with control projects, contact your local conservation district, scout troop, or watershed group to get involved.



What Campers Need To Know!

Invasive species are taking over parks and natural areas throughout Pennsylvania, making camping difficult and damaging valuable habitat. Luckily campers can play a critical role in slowing the spread of invasives.

“Invasive species” are non-native plants and animals that can cause harm to the economy, environment, and/or human health.

Invasive plants tend to grow quickly and thickly, potentially blocking trails. This makes it

more difficult for people to camp and enjoy the outdoors.

Mile-a-minute, for example, is a vine that can grow up to a foot per day! It can quickly make trails impassable with its painful spines (*see photo below*).

Invasive species are also a concern to campers because they can ruin the beauty of Pennsylvania landscapes and lower biodiversity (the variety of living things in an area).

We need biodiversity to maintain healthy habitats.

Plus it's simply more interesting and exciting to camp in a landscape full of different shrubs, trees, flowers, and grasses, rather than in a boring field of the same invasive plant. But that is exactly what could happen if an invasive species appears... all other species, including wildlife, may be chased out or killed!



Mile-a-minute vine

- Know how to identify some of the more common invasive species in your area, so you can avoid camping near them. Visit www.dcnr.state.pa.us/forestry/invasivetutorial/index.htm to learn more.
- Stick to designated trails and campsites instead of creating your own.

- Clean clothing, shoes, vehicles, pets, tents and other equipment before entering a new area to remove hitch-hiking seeds and plant parts (bag the dirt and seeds and throw that in the trash).
- Do not move firewood! Buy it locally. This will keep dangerous pest insects like emerald ash borer out of PA.

- Volunteer to help prevent and control invasive species. Contact your local state park/forest office, conservation district, watershed group, or campground to get involved.



What Campsite Lessees Need To Know!



Invasive species are taking over forest land throughout Pennsylvania, damaging valuable habitat. Luckily campsite lessees can play a critical role in slowing the spread of invasives.

“Invasive species” are non-native plants and animals that can cause harm to the economy, environment, and/or human health.

Mile-a-minute, for example, is a vine that can grow up to a foot per day. It can quickly make trails impassable with its painful spines (see photo below). Tree of heaven can replace native trees that provide food and shelter for wildlife.

Invasive species are also a concern because they can ruin the beauty of Pennsylvania landscapes and lower

biodiversity (the variety of living things in an area).

Plus it's simply more interesting when a leased campsite is surrounded by a forest full of different shrubs, trees, flowers, and grasses, rather than the same invasive plant. But that is exactly what could happen if an invasive species appears...all other species, including wildlife, may be lost.



Mile-a-minute vine

Make A Difference!

Now that you know why invasive species are a concern, what can you do to help minimize their spread? Luckily there are many small, easy steps you can take to keep invasives in check.

Make sure that you have approval from the forest district office before beginning any work on your campsite lease.

- Know how to identify invasive plants, so you know what species are present on your campsite and how they can be controlled. Look at www.dcnr.state.pa.us/forestry/invasivetutorial/index.htm for more information.
- Educate campsite visitors about invasives and what they can do to help.

- Clean off clothing, shoes, and equipment before going to a new area. Bag any dirt, seeds, and other plant parts and dispose of them in the trash.
- Only native plants may be planted on the campsite lease. Get permission from the forest district office before beginning any landscape projects on your lease.

- Use weed-free mulch like straw or woodchips, not hay which can be full of weed seeds.
- Don't move firewood! Buy it locally. This will keep out invasive insects like the emerald ash borer beetle (*shown below*), which has killed millions of trees in the Midwest.



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Low-Impact Recreational Practices for Wilderness and Backcountry

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PREFACE

This report summarizes information on low-impact recreational practices in backcountry and wilderness areas. The first section describes common problems caused by recreational use of backcountry and factors that influence the magnitude of these problems. Low-impact practices capable of substantially attenuating these problems are listed.

The second section-the bulk of the report-describes each low-impact practice, using a standard format. First, the practice is described along with sample messages for recreationists. Then the rationale for each practice is discussed, as is the importance and likely effectiveness of the practice. Controversial aspects of recommended practices and knowledge needed to increase specificity or reduce controversy are discussed. The frequency with which each practice is recommended is noted, and costs to visitors are described.

A third section discusses practices that have been recommended but that might result in problems. This section is followed by a discussion and examples of messages that emphasize visitors' understanding the rationale behind recommended low-impact practices and messages tailored to different environments and user groups. A final section discusses major research gaps in knowledge about behaviors capable of minimizing problems.

This report is intended to serve as a source book of information on low-impact practices. Managers can use the discussion of problems to identify practices they might want to recommend to visitors. The descriptions of individual practices can be used to decide more specifically what practices to recommend. The sections on developing effective messages can provide ideas and examples on how to put together a coherent set of recommended practices. The section on research gaps might prove useful to researchers seeking important topics for study.

There are three primary ways of accessing information on specific practices. Someone interested in all of the practices useful in avoiding specific problems can use the lists following the discussions of each management problem. Major categories of practices, such as all those that pertain to the use of campfires, can be located in the table of contents. Specific practices are listed in appendix A.

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Low-Impact Recreational Practices for Wilderness and Backcountry

David N. Cole

INTRODUCTION

Wilderness and backcountry areas have been designated for a variety of purposes and permit a variety of uses. These various purposes and uses often conflict with each other, causing management problems. Recreational use is a good example. Recreational use can alter vegetation, animal behavior, soil, and water, compromising the integrity of ecological, geological, scientific, scenic, and historical values. By diminishing opportunities for solitude, recreational values can also be compromised. Management problems resulting from recreational use of wilderness and backcountry (terms that will be used interchangeably hereafter) can and have been dealt with in many ways. Cole and others (1987) discuss the pros and cons of alternative strategies for dealing with these common problems.

As wilderness use and its impacts have grown in magnitude, so have restrictions on that use. Regulations have proliferated, resulting in a new problem—restriction of the free and spontaneous nature of wilderness recreation. Ever-increasing regulation has precipitated concern that management has become unnecessarily authoritarian (Lucas 1982). An alternative approach has been advanced, stressing information and education. If informed users will voluntarily behave in ways that minimize problems, then regulation can be less pervasive.

The notion that management through voluntary compliance is preferable to authoritarian control has considerable appeal to managers and visitors alike. Most managers are uncomfortable with the "police" role that regulation requires of them, and visitors usually prefer to retain freedom of choice. Consequently, both managing agencies and advocates of recreational use have been quick to express their support for information and education programs (Frome 1985). Considerable progress in the development of mitten materials about low-impact practices has been made. Techniques are taught in "how-to" books (for example, Hart 1977; Petzoldt 1974; Simer and Sullivan 1983), books specifically on low-impact techniques (Hampton and Cole 1988; Waterman and Waterman 1979), popular articles (for example, Curtis 1982; Hart 1980; Manning 1980; Wallace and DeBell 1982), and in brochures and pamphlets developed by land-managing agencies and user groups. Low-impact practices are also presented through such media as video, slide tapes, and face-to-face contact between rangers and visitors (Martin and Taylor 1981).

Although much thought has gone into development of these materials, there has been virtually no formal evaluation of the accuracy or effectiveness of the practices that have been recommended. Most recommendations are commonsense judgments derived from personal experience and are generally accepted. Some of these recommendations are contradictory and controversial, however. Moreover, research results relevant to predicting likely consequences of recommended actions have often been overlooked, and rationales for recommended actions have seldom been developed.

Considering the time and effort being expended on developing low-impact educational programs, it seemed worthwhile to systematically review current knowledge and experience. The development of effective wilderness education will require understanding of both *what* information to provide and how to convey this information to visitors. This report addresses the "what" aspect, the content of educational messages. What should we be telling wilderness visitors?

This report does *not* address the question of how to effectively deliver these messages. This subject will require innovative thinking, experimentation, and analysis. To date, Martin and Taylor (1981) have compiled the most comprehensive report on this subject.

Most of this report consists of two sections. The first section describes major management problems, and the characteristics of visitor use and behavior that aggravate each problem. Practices are identified that will minimize each problem. By linking recommended practices to specific problems, it is easier to provide a rationale for practices and to evaluate the likely

effectiveness of each recommendation. Providing good reasons for recommendations is generally considered important to getting visitor compliance. Clear definition of linkages between problems and practices is also critical when evaluating the appropriateness of recommendations that have both positive benefits and negative consequences.

The second major section describes both generally recommended low-impact practices and frequently recommended practices that may be counterproductive. To prepare this section, 90 examples of low-impact materials were collected from a variety of sources and regions of the Nation. The recommendations provided were evaluated for consistency among sources and with the results of research. Most practices can be generally recommended. A number of recommended practices are controversial, however. Some have potentially negative consequences. For some of these, the negative consequences can be predicted given current knowledge; for others, tests of effectiveness are needed. Controversy also results from making recommendations that are arbitrary, overly specific, or that apply in some situations but not in others. Finally, a number of recommendations would be more useful if they were more specific, but further research is needed to provide this specificity.

In this report, "controversy" refers to differences of opinion about appropriate low-impact recommendations or situations where research results conflict with recommendations. A major objective of this report is to highlight and, where possible, resolve these controversies. The term is not used to refer to recommendations that are controversial to users who object to a generally recommended practice. For example, there is little controversy about the validity of recommending that stoves be used instead of fires in popular timberline destination areas. Nevertheless, many visitors may find this recommendation controversial because they are accustomed to and enjoy campfires.

In addition to the two major sections, this report discusses the importance of, and how to tailor, low-impact messages to specific user groups and environments. Although some practices are universal, the applicability of others varies, depending on whether the user travels on horseback or carries a backpack, and whether the visit is to desert or to alpine tundra. Comprehension and retention are likely to be greater when information is targeted more specifically and the information provided can also be more specific, making it more useful. Other sections of this report describe gaps in knowledge, provide examples of educational materials, and describe some desirable characteristics of such materials.

EDUCATION-A PERSONAL VIEW

Many of the low-impact educational materials I reviewed were simply lists of "do's and don'ts" -things to do and things not to do. Such lists are strikingly similar to lists of rules and regulations. The primary difference is that the lists of do's and don'ts used words such as "discouraged" instead of "prohibited", or "encouraged" rather than "required." Often the only difference in phraseology is whether or not the statement is backed up by Federal regulations. It has been argued that this difference is important because visitors retain freedom of choice (Lucas 1982). I do not disagree, and I believe that lists of do's and don'ts can be useful. But I also believe that the type of education that is needed to reduce impacts substantially is something very different.

Educational programs need to do more than teach visitors what to do. Such programs must change the way people think about their behavior. Simply changing what visitors do would be effective if it were possible to list a set of practices that were appropriate in all circumstances. Unfortunately, this is not possible. The right practice in one situation can be the worst thing to do in another situation. For example, when following a trail, parties should walk single file down the middle of the trail. When walking off-trail, however, people should spread out to avoid creating a trail.

Visitors need to be taught how to evaluate and weigh a variety of factors, and how to select the course of action most likely to minimize problems. They need to use judgment, as well as follow specific techniques for minimizing impact.

Teaching visitors how to evaluate different situations would produce additional benefits. It would provide a framework for incorporating new information and experience. As will become obvious in the entries for "knowledge needs" in the descriptions of practices, there is a lot that we do not know about low-impact practices. A framework for organizing new knowledge would help each person to continually improve low-impact skills. Commitment to low-impact techniques is also likely to be greater if visitors possess a framework for evaluating appropriate behavior. Satisfaction should be greater after having figured out the right thing to do, instead of simply complying with a recommended practice. The reasons for and importance of behaving in certain ways should also be more apparent.

Educational programs tend to provide little rationale for recommendations. For example, visitors are commonly asked not to camp close to lakes; however, defensible reasons for this request are seldom offered. Without a rationale, visitors may not understand why the action is important and may decide that it is not important. They are more likely to interpret recommendations incorrectly, and they are less likely to think of additional means of mitigating the problem. The need to pay more attention to rationale is the primary motivation for the discussion of problems in the subsequent section.

Programs also suffer from a common belief that it is necessary to state practices as universal rules. This tendency reflects a common opinion that most visitors are incapable of making complex judgments—a debatable point. Unfortunately, it is not possible for all recommendations to be simple rules that apply everywhere. Walking silently to maintain solitude seems to be a universally good idea, but in grizzly bear country one wants to make lots of noise to avoid surprising bears. Advice about where to camp is much more complicated, with many more variations and tradeoffs. It simply cannot be reduced to a set of universal do's and don'ts. Clearly the best choice is to train visitors in the art and science of making judgments based on a variety of factors.

In sum, low-impact wilderness education must be an ethic and a way of thinking if it is to realize its full potential. It is more a matter of attitude and awareness than of rules and regulations. Otherwise, educational programs will differ little from a system of officially sanctioned rules and regulations. Visitors need to be aware of the most critical management problems and the actions they can take to minimize those problems. They must learn how to evaluate a variety of factors—such as soil, vegetation, wildlife, weather, the amount and type of use a place receives—and then use this analysis and past experience to select appropriate practices. This requires both respect for and trust of visitors. A large proportion of wilderness visitors are well educated (Roggenbuck and Lucas 1987). Where visitors will not cooperate voluntarily, there is little choice other than management through regulation and law enforcement.

Implementing low-impact education is a difficult task that will take considerable time and effort. It represents a long-term goal. Similarly, certain recommendations in this report may appear overly "pure." They clearly would require dramatic changes on many users' part; however, they are not as "pure" as some reviewers wanted. Again, I advance these practices as reasonable long-term goals.

In the short term, practical considerations will preclude highly ambitious educational programs and expectations of immediate changes in behavior. It will be necessary to begin by teaching relatively simple practices and concepts and to nudge users away from traditional high-impact practices. Nevertheless, it is important to keep long-term goals in mind.

MANAGEMENT PROBLEMS

Management problems could be discussed at various levels of generalization. All problems resulting from recreational use of wilderness could be sorted into two categories—adverse ecological impacts and adverse impacts on visitor experiences. At the other extreme, it would be possible to list scores of different types of ecological impacts at campsites (tree damage, vegetation loss, campfire damage, and so on). A useful intermediate level of analysis used elsewhere (Cole and others 1987) identifies eight major types of problems, several of which have **been** divided into subproblems. These will be discussed in order of their perceived prevalence in wilderness (Washburne and Cole 1983). After each subproblem, the low-impact practices judged to be most important to minimizing problems are listed.

Trail Problems

Most problems associated with constructed trails result from poor trail construction and maintenance rather than either too much use or improper use of the trail (Cole 1983a; Helgath 1975). Two useful guides to trail construction and maintenance are Birchard and Proudman (1981) and Proudman and Rajala (1981). Although most deterioration problems would not occur if trails were properly located and/or engineered (management actions outside the realm of visitor education), certain types of visitor behavior aggravate trail deterioration. A second subset of trail problems results from the development of user-created trails in places where trails are unwanted. These two subproblems will be treated separately.

Deterioration of Constructed Trails—The most common types of deterioration on constructed trails are erosion, muddiness, trail widening (often the result of a muddy trail), and the creation of multiple trails and switchback shortcuts (Cole 1987b). As just mentioned, proper location, engineering, and maintenance of constructed trails are the most effective

means of avoiding these problems. In certain locations, without necessary engineering, any use will result in erosion and muddiness. The tendency, however, for visitors to leave the constructed trail, where these conditions exist, exacerbates these problems. Where trails are narrow and deep, or wet and muddy, the natural tendency is to walk along the edge of the trail rather than in the trail tread. This causes widening of muddy quagmires and/or the development of multiple parallel trails. Similar problems result from leaving the trail to shortcut a switchback. The shortcut becomes a trail (usually steep), is used more frequently, and deteriorates rapidly.

Two other factors influence the severity of deterioration problems. Trails are more prone to muddiness, widening, and the development of multiple trails when the ground is wet and water-saturated. While these conditions may occur sporadically and unpredictably (such as after summer thunderstorms), they may be particularly prevalent at certain seasons, such as during and shortly after snowmelt. Avoiding use at this time can effectively reduce the potential for trail deterioration.

Finally, compared to hiking parties, parties with packstock have more potential to cause trail deterioration (Weaver and Dale 1978). Where parties with packstock leave the constructed trail, deterioration occurs rapidly. Similarly, the potential for damage during seasons when soils are water saturated is particularly high when parties travel with stock. Therefore, all of the low-impact practices intended to minimize deterioration of constructed trails are considerably more important for parties with packstock.

For hiking parties the most important low-impact practices are:

- Avoid trips where and when soils are wet and muddy (page 20).
- Walk single-file and keep to the main tread (page 31).
- Do not shortcut switchbacks (page 34).

All of these practices are particularly important for parties that travel with stock. In addition, the following important practices are unique to parties with stock:

- Use properly trained stock (page 78).
- Minimize the number of stock (page 80).
- Stock should stay on established trails as much as possible (page 81).
- Remove trail obstacles instead of skirting them (page 82).
- Lead stock on the trail, rather than loose-herd them (page 83).

Development of Undesired User-Created Trails- Undesired user-created trails develop along popular crosscountry routes and in popular destination areas. They result from too many feet trampling the same strip of vegetation and ground. Many of these trails were previously animal trails, altered by the trampling of animal hooves. The problem is that obvious paths tend to attract more use, which results in further development of a trail system. Unplanned trail systems are often poorly located, so erosion can be particularly severe even with low use. They also tend to braid and proliferate widely, eventually resulting in more alteration than would have been the case with construction of a planned trail. More areas are developing specific objectives to keep areas trailless; such trail systems clearly defeat these objectives.

User-created trails result from too many people following in precisely the same path. The major way to avoid this is to have people spread out. This reduces the frequency any single place gets stepped on. The number of times any place can be stepped on before a trail develops depends on the fragility of the ground surface and the destructive force of the trampler. Therefore, trails are more likely to develop on fragile vegetation and ground surfaces or during seasons when the ground is water-saturated. They are also more likely to develop when trampled by stock, rather than by hikers (Weaver and Dale 1978). Similarly, where it is difficult to spread out, trail development is more likely following the passage of a large party because more feet are likely to fall on the same path.

In some places, use levels are so high that spreading out would simply create many trails all over the place. Ideally, management should establish an "official" trail system in such places (or reduce use levels dramatically). Where managers have taken neither of these actions, users can help the situation by treating the most obvious of the user-created trails as a constructed trail and staying on it. While this will not avoid the creation of user-created trails, it will limit their proliferation.

For hiking parties, the most important low-impact practices are:

- Keep party size small (page 18).
- Avoid trips where and when soils are wet and muddy (page 20).
- Avoid off-trail travel unless prepared to use extra care (page 22).
- Avoid walking on closed trails and/or developing user-created trails (page 30).
- Spread out when walking off trail (page 37).
- Do not mark cross-country routes (page 38).
- Choose a cross-country route that crosses durable surfaces (page 39).
- When traveling cross country, use extra care when ascending or descending steep slopes (page 40).

All of these practices are particularly important for parties that travel with stock. Except in resistant environments, it is difficult for a party of stock to not create a new trail. Therefore, use of existing trails is always preferable to cross-country travel; parties that do choose to travel cross country must use extra care. In addition to the preceding practices, the following are unique to parties with stock:

- Use properly trained stock (page 78).
- Minimize the number of stock (page 80).
- Stock should stay on established trails as much as possible (page 81).

Campsite Problems

The nature and magnitude of campsite problems are influenced by a variety of factors. The most important factors are how frequently the site is camped on, the type of party that uses the site (particularly size of party and whether or not they have stock), the behavior of campers (including, particularly, whether or not they have a campfire), and the fragility of the site (Cole 1987b). Season of use can also affect fragility and, therefore, is sometimes a significant factor. Low-impact practices are available that can take advantage of the influence of each of these factors.

Extensive research has shown that the relationship between frequency of use and amount of impact is complex; it varies with the use levels being compared (Cole 1987b). When comparing two infrequently used campsites, the more frequently used site is likely to have experienced considerably more impact. This is not the case when comparing more frequently used sites, however. Levels of impact may be comparable on sites receiving quite different levels of use. The major implications of this finding are: (1) keeping use of infrequently used sites to very low levels is an effective means of minimizing impact on these sites; (2) on the other hand, lightly used and lightly impacted sites, if used more frequently, are likely to deteriorate dramatically; and (3) on frequently used sites, neither increasing nor decreasing use is likely to have a substantial effect on amount of impact (Cole and Benedict 1983). But whenever use levels are reduced on certain sites, other sites will be used more frequently and the potential for the creation and deterioration of new sites increases. As long as use frequencies remain extremely low on all sites, deterioration may not occur and use dispersal may not lead to site proliferation. Where it is not possible to maintain very low frequencies on sites, use dispersal will merely increase the number of impacted sites (Cole 1982a).

These findings and implications suggest two positive ways to limit campsite problems and one situation that should be avoided. Because increased use of frequently used sites is not likely to cause much further damage, camping on sites that are already well impacted will confine deterioration to a small number of sites. Alternatively, where it is possible to use sites so infrequently that they never deteriorate, camping on apparently undisturbed sites will avoid the creation of campsites entirely. The situation to avoid is use of a large number of sites at low-to-moderate frequencies sufficient to cause site deterioration. This situation can occur either in popular places or in remote, little-used places. In popular places, it results from camping on less-disturbed sites rather than on sites that are already heavily impacted. In remote places, the problem results from camping on sites that have already been disturbed. This is likely to cause further disturbance, which is likely to attract further use, which is likely to cause further disturbance, and so on. *The key- in both popular and remote places- is to never camp on sites that are obviously but lightly disturbed* (Cole and Benedict 1983).

Type of use and visitor behavior can have a substantial influence on the severity of campsite problems. Large parties and parties with packstock will disturb a larger area than will a small hiking party (all other factors being equal) because they must occupy a larger area (Cole 1983b). Campsites used by outfitted parties tend to be particularly large because these parties usually consist of a number of unaffiliated groups, each seeking some privacy (Cole and Marion 1988). Unless such parties can find an existing site that is already large enough to accommodate their group, they are likely to enlarge the area of disturbance. Enlargement is the most common detrimental ongoing change on well-established campsites (Cole 1986a). Large parties and parties with stock will also tend to disturb a pristine site more rapidly than will a small hiking party. This follows from the facts that stock hooves cause more disturbance than human feet (Weaver and Dale 1978) and that the frequency any place is trampled will increase as party size increases. Therefore, large parties and parties with stock must use extra care when camping in little-used places.

Regardless of type of use, certain behaviors cause unnecessary impact while other behaviors minimize impact. Campfires, particularly if not used with restraint and caution, cause some of the most obtrusive impacts on campsites. Parties that carry and use stoves and do not build fires avoid these impacts. Damage can also be reduced by building fires carefully, only in appropriate places, and by cleaning up after fires. Avoiding any intentional site alteration and camouflaging any inadvertent disturbance that does occur are also important, as is traffic flow on the site. Again, the appropriate principle is that it is best to spread use and impact on undisturbed sites and to concentrate use and impact on areas that are already highly impacted. Thus, on already impacted sites, tents and activities should be confined to the most disturbed parts of the site. Conversely, tents and activities should be spread out on undisturbed sites. Large groups can minimize their disturbance of pristine places by breaking up into small groups that camp some distance from each other.

Finally, it is possible to take advantage of the fact that sites vary in their ability to tolerate use. Differences in the durability of vegetation are greater where use levels are low rather than high (Cole 1987a). This follows from the fact that, given sufficiently frequent use, even resistant vegetation (such as the turf of a football field) will be removed. This means that seeking out resistant sites is most important when using an apparently undisturbed site. Sites that are entirely devoid of vegetation are always preferred. Sites on rock, unconsolidated mineral soil (for example, beaches or dry washes), snow, or ice are best for minimizing impact; however, they may not be attractive to many campers. Where vegetation is present, sites with resistant vegetation are preferred. Vegetation resistance is highly variable, making it difficult to provide generalizations that apply in different regions or even within local areas. Vegetation types dominated by grasses and grasslike plants, particularly if growth is dense and short, are usually relatively resistant, as are vegetation types with large, tough shrubs with bare soil between (Cole 1986b). On frequently used sites, no vegetation type is tough enough to survive; however, some sites have a greater ability to avoid mineral soil exposure than others. This is significant because soil compaction and erosion tend to be more severe where soil exposure is pronounced. Potential for soil exposure is least on flat sites with thick organic horizons (Cole 1985).

As with trail problems, it is useful to divide campsite problems into two subproblems. The first is excessive deterioration of established campsites, whether officially designated or spontaneously created by users. This is the type of problem most readily envisioned—large areas of barren, compacted, and eroded soil; hacked-up and sawed-down trees with exposed roots; numerous firerings with charcoal spread over the site; plank seats; tables; ditched tent sites; and so on. The second subproblem is the proliferation of undesired user-created campsites. This problem can occur at popular destinations where every "campable" site is disturbed because camping is not confined to a small number of frequently used campsites (Cole 1982a). It also occurs in little-used places, such as lake basins that have a number of moderately disturbed campsites, despite use levels so low that encounters between parties are highly unlikely. The importance of the factors affecting amount of impact and the recommendations for appropriate use differ between these two subproblems.

Deterioration of Established Campsites- On frequently used established campsites, loss of vegetation cover and soil disturbance are inevitable. The major "problems" occur where the disturbed area becomes extremely large, where trees are damaged unnecessarily, where campfire impacts are widespread, and where widespread erosion occurs. As mentioned earlier, the factors with the most influence on the severity of these problems are the type of camping party and the behavior of those campers. Enlargement is related primarily to party size and the presence of stock and occurs when too little attention is paid to

confining traffic to already impacted areas. Tree damage is a result of intentional damage, improper stock handling, and improper firewood selection. Campfire impacts result from lack of care in use of fire; erosion results primarily from selection of a site that is prone to erosion. Selection of a durable site is generally less important to avoiding deterioration of established sites than it is to avoiding site proliferation. It is most important to find a flat site with a ground surface that, before camping, would have been either unconsolidated mineral soil or thick organic horizons and, if possible, sparsely vegetated.

For hiking parties, the most important low-impact practices are:

- Select a site that is large enough to accommodate your party (page 46).
- Select a durable site (page 47).
- Minimize intentional site alteration and the building of structures (page 50).
- On established campsites, confine tents and activities to already impacted areas (page 52).
- On established campsites, dismantle any structures you built and any other inappropriate structures; leave the site clean and attractive (page 53).
- Limit the use of campfires where firewood is not plentiful (page 57).
- In places with well-impacted campsites, build fires in existing firerings or on fire scars (page 61).
- Gather firewood away from camp; disperse your gathering (page 63).
- Use only dead and down firewood that you can break by hand (page 64).
- Burn charcoal to ash; soak ashes; scatter excess firewood (page 68).
- On preexisting fire sites, leave the firering clean and attractive; dismantle extra firerings (page 70).

All of these practices apply to parties with stock. In contrast to the practices designed to minimize trail problems, these practices are not more important for stock parties; however, the following practices are unique to parties with stock:

- Use properly trained stock (page 78).
- Minimize the number of stock (page 80).
- Keep stock off campsites as much as possible (page 86).
- Keep lengths of stay at one place short (page 87).
- Use existing hitch rails and corrals where available (page 92).
- Where confinement is necessary, use a hitch line on a durable site away from water (page 93).
- Avoid tying stock to trees, particularly small trees (page 94).
- Renovate pawed-up areas; scatter manure; remove picket pins and excess feed and salt (page 95).

Proliferation of Campsites- Creation of new campsites occurs whenever use of previously undisturbed sites exceeds very low levels. In popular places this occurs where visitors do not camp on sites that are already well impacted. This situation was documented in the Eagle Cap Wilderness where 221 campsites (more than half of which had suffered substantial vegetation loss) were found in a 325-acre area around two popular subalpine lakes (Cole 1982a). In remote, little-visited places, new campsites are created where visitors camp on sites that have already been disturbed and/or that are fragile, and where visitors are not careful to minimize impact and camouflage evidence of their stay. The magnitude of proliferation problems is influenced by frequency of use and site durability, as well as type of party and visitor behavior. Apparently undisturbed sites, without vegetation or with resistant vegetation, are preferred for campsites. Widespread dispersal of activities and traffic, as well as special care to minimize and camouflage disturbance, are also important. Large parties and parties with stock must use extra care, given their potential to cause rapid damage. Substantial off-trail use by parties unprepared to use extra care is likely to result in a proliferation of sites.

For hiking parties, the most important low-impact practices are:

- Keep party size small (page 18).
- Avoid off-trail travel unless prepared to use extra care (page 22).
- In popular locations, select a well-impacted campsite (page 41).
- In remote locations, select a previously unused campsite (page 42).
- Never camp on a lightly impacted campsite (page 45).
- Select a durable site (page 47).
- Wear soft-soled shoes around camp (page 49).

- Minimize intentional site alteration and the building of structures (page 50).
- Avoid trampling vegetation (page 51).
- On previously unused sites, disperse tents and activities (page 54).
- On previously unused sites, keep lengths of stay short (page 55).
- On previously unused sites, camouflage any disturbance (page 56).
- Limit the use of campfires (page 57).
- Build fires on mineral soil where trees, roots, vegetation, or rocks will not be scarred (page 60).
- In places with well-impacted campsites, build fires in existing firerings or on fire scars (page 61).
- In places without well-impacted campsites, do not use existing firerings or scars; dismantle any rings (page 62).
- On previously unused fire sites, build fire in a shallow pit or on a mound of mineral soil (page 65).
- Do not ring a fire with rocks (page 66).
- Keep fires small (page 67).
- Burn charcoal to ash; soak ashes; scatter excess firewood (page 68).
- On preexisting fire sites, leave the firering clean and attractive; dismantle extra firerings (page 69).
- On previously unused fire sites, remove all evidence of the fire (page 70).

All of these practices are important for parties with stock as well. Low-impact practices that are unique to parties with stock include:

- Use properly trained stock (page 78).
- Minimize the number of stock (page 80).
- Keep lengths of stay at one place short (page 87).
- Use existing hitch rails and corrals where available (page 92).
- Where confinement is necessary, use a hitch rail on a durable site away from water (page 93).
- Avoid tying stock to trees, particularly small trees (page 94).
- Renovate pawed-up areas; scatter manure; remove picket pins and excess feed and salt (page 95).

Litter Problems

Litter is a common problem in wilderness and is one of the more important factors detracting from the experience of visitors. But it is perhaps the simplest problem to correct. It is the only problem that can conceivably be eliminated. Although a simple solution is not necessarily an easy solution, there is some evidence that litter problems have diminished in recent years (Lucas 1985).

Clearly, the cause of litter problems is improper disposal of items brought into the wilderness. The general policy of "pack-it-in, pack-it-out," if strictly followed, could eliminate littering. Several problems arise, even for conscientious visitors, however. Certain items (used toilet paper, leftover food scraps, and so on) are unpleasant to pack out. Other items are easily misplaced and left behind. This has prompted suggestions about items to bring or not to bring. An example might be packaging food in "zippered" plastic bags, rather than in bags with "twist-ties" that are easily left behind. Other problems result from attempting to burn items that will not burn (such as aluminum foil).

The few important low-impact practices relevant to this problem are:

- Carry appropriate equipment (a trash bag) (page 16).
- Pack out nonorganic litter (or burn readily burned litter) (page 71).
- Pack out or burn organic garbage (or scatter fish viscera) (page 73).

All of these practices are important for parties with stock, as is the following additional practice:

- Scatter manure; remove picket pins and excess feed and salt (page 95).

Crowding and Visitor Conflict

Interaction between parties is a frequently cited source of visitor dissatisfaction (Stankey and Schreyer 1987). As with campsite problems, the magnitude of crowding and conflict problems is influenced by the frequency of interaction, the types of parties encountered, the behavior of individuals in those parties, and the location of encounters (Manning 1986).

A basic assumption of wilderness management is that as interaction between wilderness visitors increases, opportunities for solitude and therefore the quality of the wilderness experience decrease. Research, however, has had surprising difficulty in showing a strong negative relationship between frequency of encounters and satisfaction. Stankey (1973,1980) found a strong preference among wilderness visitors for low levels of contact, but responses were based on hypothetical encounter levels. In real wilderness situations, researchers have seldom been able to effectively isolate the effect of frequency of contact on the experience. It is clear that as interaction increases, opportunities for solitude (a critical goal of management) will tend to decrease; moreover, many visitors express the desire not to see "too many other people." Therefore, it is safe to conclude that high levels of interaction cause problems.

One of the reasons for the difficulty in finding a correlation between contact levels and satisfaction is the importance of variables other than frequency of contact. Mode of travel is one important mediating factor. Interactions between hiker and stock parties are more dissatisfying, particularly to the party of hikers, than interactions between similar parties (Stankey 1973). The same is true for contacts between parties using motorized and nonmotorized boats, a situation that occurs in portions of a few wilderness areas. A similar situation occurs in some contacts between parties traveling with and without dogs. Party size is another mediating factor. Stankey (1973) has also reported that visitors prefer seeing many small groups to a single large group.

In all of these cases, there is an asymmetrical relationship between two different types of party. Hikers, nonmotorized boaters, parties without dogs, and small parties are often disturbed by contact with their opposites, despite little reciprocal concern. The concerned parties apparently perceive the other type of use as inappropriate or undesirable and, consequently, conflict occurs when the parties interact. Conflict also results when any individual breaks someone else's norms of appropriate behavior and is observed in the act, or the consequences of that act are observed. Examples include raucous behavior, shooting guns, littering, or any other observable environmental impact.

Finally, the location of contacts can influence problem severity. Interaction between parties camped close to each other is generally more of a problem than contacts along the trail or elsewhere (Stankey and Schreyer 1987). Encounters that occur in more remote portions of the wilderness also tend to be more troubling than encounters close to the edge of the wilderness (Stankey 1973). This tendency, along with the fact that satisfaction is strongly related to expectations about number of encounters (Stankey and Schreyer 1987), suggests that visitors in little-used portions of the wilderness will have less tolerance for contacts than will visitors to popular places, regardless of proximity to trailheads.

It is possible to differentiate between problems resulting simply from meeting too many other people (too many encounters) and problems resulting from the type of encounter (conflict). The distinction is not always clearcut, and each subproblem aggravates the other. Visitors are likely to feel particularly crowded if many contacts are of a conflicting nature. Conversely, a perception of conflict is more likely if contacts are frequent. Nevertheless, the distinction is useful because certain low-impact practices are relevant to one or the other of the subproblems.

Too Many Encounters-The number of encounters judged to be "too many" differs between visitors and with a number of situational factors. Nevertheless, because many visitors desire low levels of interparty contact, the goal of low-impact practices should be to minimize interaction with other parties, particularly where they are camped and in remote and little-used portions of the wilderness. Interaction extends beyond mutual visual contact to include other people viewing you (and particularly your camp) without your knowledge and other people hearing you.

Perhaps more than for any other problem, it would be possible to carry attempts to minimize encounters to extremes. Encounters with others could always be minimized by never walking on trails or by never visiting places at times of the year when others do. The following low-impact practices can help minimize problems without requiring drastic changes in preferences and behavior:

- Choose clothing and equipment colors that blend with surroundings (page 15).

- Be quiet in the wilderness (page 24).

- Take trailside breaks off trail on a durable site (page 35).

- Select a concealed campsite away from trails, occupied campsites, lakes, and other water bodies (page 48).

Two other commonly suggested practices cannot be generally recommended because, in my view, their negative consequences may outweigh their positive benefits. Those practices are ‘visit wilderness during less popular days of the week and/or seasons’ (see page 96) and “avoid visiting more popular places in the wilderness” (see page 97). Each of these practices, if successful, would decrease encounters in some places and at some times, but they would tend to increase encounters in other places and at other times. The times and places where and when encounters would increase are those where and when encounter levels are currently low. Although data are scanty and merely suggestive, these are the situations where visitors appear to be most intolerant of increased interaction with others. There certainly are situations in which the tradeoffs implicit in either of these practices suggest a positive benefit/cost ratio (an obvious example is any situation where even after the shift in use, no encounters occur), but these practices appear to be risky as general recommendations.

Visitor Conflicts- Although influenced by the number and location of encounters, the major factors that determine severity of conflict are the type of party encountered and the behavior of individual visitors. Hiking parties can minimize problems with the following low-impact practices:

- Keep party size small (page 18).
- Keep pets under restraint or leave them at home (page 23).
- Be quiet in the wilderness (page 24).
- Step off the trail, downslope, when encountering a stock party (page 36).

While these are the practices that will minimize face-to-face conflict, all of the practices to minimize litter, human waste, campsite, trail, and grazing area problems will also reduce conflict. These other impacts, if recognized, are signs of inappropriate behavior and therefore contribute to perceived conflict.

All of the stock-handling low-impact practices are important in that they will minimize the impacts caused by stock, impacts that many feel result from inappropriate use of wilderness. Practices with particularly direct abilities to reduce conflict are:

- Minimize the number of stock (page 80).
- Tie stock off trail, on a durable site, when taking a break (page 84).
- Keep stock off campsites as much as possible (page 86).
- Renovate pawed-up areas; scatter manure; remove picket pins and excess feed and salt (page 95).

Deterioration of Grazing Areas

Packstock cause substantial problems in some backcountry areas. They contribute to problems on trails and campsites, as well as crowding and visitor conflict. Practices important to minimizing these problems have already been listed. One additional impact unique to parties with stock is deterioration of grazing areas. Places where stock are confined and/or allowed to graze are altered by frequent defoliation of plants and by trampling. This causes cover loss, shifts in species composition, and loss of forage, and can result in destabilization of streambanks, lowering of water tables, and invasion of “weedy” species (DeBenedetti and Parsons 1979). This in turn can have adverse impacts on wildlife through competition for limited forage and reductions in forage production.

The effects of packstock grazing on natural ecosystems in wilderness are not well understood; neither are the factors that influence amount of deterioration. Results of range studies conducted elsewhere suggest that low to moderate levels of grazing may not cause adverse impacts, as long as stock are kept off fragile sites. One primary cause of severe deterioration is excessive grazing pressure. This can result from having too many animals, staying in one place too long, or not rotating stock frequently enough. This problem can be partially alleviated by packing in weed-free supplemental feed so there is less demand for limited forage. But even then trampling damage can be serious. The other primary cause is grazing of places that are particularly fragile or grazing at times of the year when fragility is high. Grazing of wet meadows and riparian strips, as well as grazing during times of year when soils are water saturated, can be particularly destructive.

This suggests the value of the following low-impact practices:

- Avoid trips where and when soils are wet and muddy (page 20).
- Use properly trained stock (page 78).
- Minimize the number of stock (page 80).
- Avoid places that have already been heavily grazed (page 85).
- Keep lengths of stay at one place short (page 87).

Water stock downstream from drinking sources on a durable spot (page 88).
Carry an appropriate amount of weed-free supplemental feed (page 89).
Place feed and salt on a tarp or in a feedbag or container (page 90).
Minimize confinement of stock when grazing; move picketed stock frequently (page 91).
Renovate pawed-up areas; scatter manure; remove picket pins and excess feed and salt (page 95).

Human Waste

Human waste generally cannot be treated in a pack-it-in, pack-it-out manner, although this has become increasingly common on boating trips. Instead, it must be left in the wilderness. The presence of human waste in the wilderness is not a problem; problems result when other humans come into contact with waste, either directly or through drinking contaminated water. This suggests the obvious behavior necessary to minimizing impact-depositing feces away from lakes and streams, and places where others might come into contact with them. This latter constraint has not been considered a major problem because of the widespread belief that buried feces will decompose rapidly. Recent research in the Rocky Mountains found, however, that pathogenic organisms can survive in buried feces for a year or more (Temple and others 1982). Decomposition is not rapid. Therefore, it is important to bury human waste in places where it is unlikely to be uncovered for years.

Generally, human waste problems are serious only in destination areas where use is quite high and toilets are not provided. In these places, in addition to being careful to bury waste in a location away from water, it is important to walk a considerable distance away from campsites to find a burial site. Otherwise, there is a significant risk of contracting disease by unearthing feces with viable pathogens. In less popular places, widespread dispersal is less critical and in very remote places, surface disposal has even been recommended. This latter recommendation can be beneficial, particularly at high elevations where digging a hole can create an unnecessary disturbance that might take years to recover; however, the risk it presents in inappropriate situations makes it a controversial practice. Toilet paper, as with other nonorganic waste, should either be burned or packed out. Burial is a less desirable alternative-but accepted practice in many places.

Important low-impact practices are as follows:

- Carry appropriate equipment (trowel) (page 16).
- Pack out (or bum) nonorganic litter (toilet paper) (page 71).
- Use toilets if provided (page 74).
- Dispose of human waste in a properly located cathole (page 75).

Wildlife and Fishery Impacts

Although a number of case studies of recreational impacts on animals have been conducted (Boyle and Samson 1983), we lack an understanding of the prevalence or significance of impacts on animals or fisheries. There is also little understanding of the importance of factors that influence amount or type of impact; consequently, few specific recommendations about low-impact behavior can be made. This is clearly a critical information gap. Nevertheless, it is possible to speculate about some influential factors that are likely to be important.

Amount and frequency of disturbance are likely to be important. There are probably cases where occasional human intrusion would elicit little response, while frequent intrusion would cause displacement, nest abandonment, or some other undesired effect. But in a study of the effects of crosscountry skiers on elk and moose, Ferguson and Keith (1982) found that movement occurred following the first encounter with humans; the passage of additional skiers caused no further disturbance. Some researchers have found that animals become habituated to human intrusion, making them less disturbed by human presence (Schultz and Bailey 1978). Others report more substantial disturbance of populations that have had more frequent encounters with humans. Although fewer encounters would generally be desirable, it is not clear what the aggregate effect of changes in the distribution of human use would be. Shifting more recreational use to places and seasons of the year that are currently little used certainly has the potential to increase problems.

Party characteristics appear unlikely to influence amount of disturbance substantially. Parties with packstock can compete with animals for limited forage in some places. Generally, however, the behavior of individuals is probably more important than characteristics of the party. For example, whether or not individuals engage in hunting or fishing can have a pronounced effect on disturbance; so can decisions about where to camp and one's care in approaching animals for a better view or a photograph.

Disturbance is more likely to occur at certain times of the year-for example, during birthing seasons or other times of stress. Disturbance is also more likely in some places than others. For example, human presence at desert waterholes will be much more disruptive than in places away from water.

Three distinct subproblems can be identified: (1) Unintentional harassment of animals, usually scaring them by approaching too closely or being some place they want to be. (2) Feeding animals or attracting them through improper camping techniques. This can cause adverse changes in feeding habits. (3) Competition with wildlife where excessive grazing occurs. (Hunting and fishing also cause disturbance; these intentional disturbances are not treated here.)

Animal Harassment- Disturbance of wildlife is most strongly related to user behavior and where and when disturbance occurs. Few specific practices can be suggested; the following suggestions are appropriate:

- Avoid trips where and when animals are particularly vulnerable to disturbance (page 21).

- Avoid off-trail travel unless prepared to use extra care (page 22).

- Keep pets under restraint or leave them at home (page 23).

- Avoid harassment of animals (page 27).

- Select a campsite away from lakes and other water bodies (page 48).

Disturbance of Feeding Habits-The severity of this problem is related primarily to visitor behavior. Animals should not be fed anywhere. It is also important to protect food from animals and, particularly at campsites, to avoid attracting animals. Specific practices are: .

- Do not feed animals (page 28).

- Protect food from animals (page 29).

- Pack out or burn organic garbage (or scatter fish viscera) (page 73).

Competition-Competition with wildlife occurs only where there is excessive grazing of forage needed by wildlife. It is unclear how serious a problem this is. The factors that would likely influence problem severity include amount of grazing, grazing behavior, and where and when grazing occurs. Practices with the potential to minimize competition include:

- Avoid off-trail travel unless prepared to use extra care (page 22).

- Minimize the number of stock (page 80).

- Keep lengths of stay at one place short (page 87).

- Carry an appropriate amount of weed-free supplemental feed (page 89).

Water Pollution

Of all recreation-related management problems, water pollution is probably the least understood. We know little about the severity, prevalence, or even the nature of problems. Health hazards due to fecal contamination have been the primary concern. Studies that have attempted to quantify the incidence of fecal contamination and identify causal links to recreational use usually generate negative results. Bacterial contamination is seldom a problem (see, for example, Silverman and Erman 1979), and is often more problematic in places without recreational use because wild animals are the primary vectors of contamination (Stuart and others 1971). Contamination with *Giardia* spp. is a more common problem in wilderness. In the Sierra Nevada, Suk and others (1986) found *Giardia* cysts in 27 of 78 water samples, and cysts were particularly common in samples collected just downstream from popular campsites. Practices designed to mitigate this problem were discussed in the section on human waste. In addition, visitors are more often turning to water filtration or treatment to deal with the problem.

More insidious, and even less frequently documented, are more subtle changes in aquatic ecosystems. For the same lakes where bacterial contamination was not a common problem, Taylor and Erman (1979) documented changes in ion concentrations and aquatic flora and fauna. They speculated that these changes resulted from increases in the concentration of limited nutrients as a result of camping, bathing, washing, and other recreational activities close to the lakeshore. These changes, along with the changes related to stocking fish and angling, suggest that alteration of aquatic ecosystems may represent our greatest failure to "preserve natural conditions" in wilderness.

The primary influences on problem severity are related to where recreational activities occur. The most important low-impact practices are:

Select a campsite away from lakes and other water bodies (page 48).
Dispose of human waste in a properly located cathole (page 75).
Bathe, wash, and dispose of waste water away from water bodies (page 77).

Stock users should also practice the following:

Water stock downstream from drinking sources on a durable spot (page 88).
Where confinement is necessary, use a hitch line on a durable site away from water (page 93).

Other Problems

A few other practices do not apply to any of these specific problems, but relate to avoiding unnecessary disturbance of natural and cultural features. Important practices for all users include:

Minimize disturbance of natural features (page 25).
Do not disturb cultural artifacts or archeological sites (page 26).
Do not build a fire where fire danger is high (page 59).

RECOMMENDED LOW-IMPACT PRACTICES

In the sections that follow, recommended low-impact practices are described in detail. These are practices judged to be likely to contribute to minimizing impact problems. They have been grouped into seven categories. A complete list of recommended practices can be found in appendix A.

1. *Trip preparation.* Planning can be important to minimizing impact. Clothing and equipment are important (practices 1 and 2), as are party size (practice 3) and deciding where and when to visit (practice 4-6).
2. *General conduct.* Behavioral guidelines that apply at all times during a backcountry visit pertain to handling of pets (practice 7), noise levels (practice 8), disturbance of natural and cultural features (practices 9 and 10), and disturbance of animals (practices 11-13).
3. *Backcountry travel.* Appropriate practices when traveling in the backcountry differ between travel on existing trails (practices 14-18) and crosscountry travel (practices 19-22).
4. *Campsite selection and behavior.* Camping practices pertain to both selection of a site and appropriate behavior once a site has been selected. Campsite selection criteria (practices 23-28) include level of previous impact, size of the site, durability, and location. Certain behavioral practices apply to all campsites (practices 29-31). Some practices apply only when using well-established campsites (practices 32 and 33); others apply only when using previously unused sites (practices 34-36).
5. *Campfires.* Minimizing impacts associated with campfires begins with deciding whether or not a campfire is appropriate and, if it is, where it should be built (practices 37-42). Other practices pertain specifically to firewood selection and gathering practices (43 and 44, construction of a fire on a previously unused site (practices 45 and 46), and campfire use and cleanup (practices 47-50).
6. *Waste disposal and sanitation.* These practices apply to disposal of garbage (practices 51-53) and human waste (practices 54 and 55), as well as to proper methods of bathing and washing (practices 56 and 57).
7. *Additional practices for parties with stock.* Parties that travel with stock need to **con-**sider all of the preceding 57 practices. In addition, there are a number of additional practices of critical importance to minimizing impacts unique to stock parties. Specific practices pertain to equipment and trip preparation concerns (practices 58-60), practices when traveling on existing trails (practices 61-64), campsite selection (practice 65), campsite behavior (practices 66 and 67), watering, feeding, and grazing stock (practices 68-71), confining stock (practices 72-74), and cleanup (practices 75).

The treatment of each practice provides the following information:

Description- This section provides a short narrative description of the recommended behavior.

Sample Message(s)- One or more good examples from low-impact materials illustrate the practice. Numbers in parentheses allow ready reference to the materials listed in appendix B.

Problem(s) Addressed and Rationale- Problems are cross-referenced to those just discussed. More detail is provided on why the practice should minimize problems. Visitor commitment to low-impact practices is likely to be greater where the rationale behind recommendations is communicated to visitors.

Importance-This section provides an estimate of the importance of the recommended practice. Both the effectiveness of the practice in minimizing problems and the importance of problems are considered. Importance is judged high only where the practice is effective and the problem addressed is significant. Clearly, when developing a low-impact message, highest priority should be given to those practices that effectively minimize the most important problems.

Controversial Elements- For some practices, recommendations are controversial or inconsistent. Attempts to be overly specific or quantitative often result in inconsistency. Attempts to provide universally applicable recommendations, when practices are only appropriate in certain situations, also result in inconsistency. This section includes discussions of controversial and inconsistent elements and suggests means of minimizing controversy. This section does not refer to how controversial recommendations may be to visitors who might dislike a recommendation that is generally considered to be worthwhile.

Knowledge Needs- Information needs that would allow more effective application of the practice are described. This section spells out further information needed by researchers and managers, not information that needs to be transferred to visitors. Major research gaps are also highlighted in a subsequent section.

Frequency of Recommendation- How frequently each practice is recommended is estimated from the sample of source materials in appendix B. Very common practices are those recommended by at least 50 percent of the sources, while common practices are recommended by 20 to 50 percent of the sources. Uncommon practices are recommended in 5 to 20 percent of the sources. Rare practices are those that have been recommended, but by less than 5 percent of the sources.

Costs to Visitors- An estimate of the extent to which applying the practice is a burden to visitors. Time, effort, the extent of behavioral change required, and the number of visitors affected are all considered. Costs are highest where large numbers of visitors are asked to give up an activity for which there is no perceived substitute (for example, not having a campfire for esthetic purposes). Replacing large wall tents with small, lightweight tents is an example of a practice that is less costly because a reasonable substitute is available. Some comfort and convenience may be lost, but the function of keeping dry is retained.

Special Situations- This category is provided only for practices that are modified under certain circumstances.

Practices that have been recommended by some--but that may cause more problems than they correct--are described in a section on practices that can be counterproductive (see pages 96-99). The division into practices that are generally recommended and those that may be counterproductive, as well as the resolution of controversial elements are my opinions. These opinions are based on considerable research and experience as well as analysis of low-impact materials and widespread review of this report. These opinions are open to debate. Further research may suggest new ideas and practices and will undoubtedly increase the specificity and usefulness of recommendations.

Trip Preparation

PRACTICE I-CHOOSE CLOTHING AND EQUIPMENT COLORS THAT BLEND WITH SURROUNDINGS

DESCRIPTION	The colors of clothes and equipment should be muted so that they are not visible from long distances.
SAMPLE MESSAGE	"To help you travel and camp inconspicuously, select darkcolored tents, clothing, and packs when you buy new gear. Earth-tone rusts, browns, and greens blend in best with the forest. Oranges, blues and other bright colors stand out like spotlights and contribute to a crowded feeling." (8)
PROBLEM ADDRESSED AND RATIONALE	Too many encounters. When visitors wear clothes and carry equipment in bright colors that contrast with surroundings, they are more likely to be observed. The more frequently visitors observe each other and their camps, the less solitude they feel. Therefore, selection of clothes and equipment in colors that blend with the surroundings can reduce the number of encounters and increase feelings of solitude.
IMPORTANCE	Moderate. Avoidance of bright colors is only a partial solution to crowding problems. It is much more useful in dealing with crowding problems at campsites and away from trails than with problems along the trail. Colors are less likely to help avoid an encounter along the trail, and visitors are less sensitive to encounters on trails than at campsites (Stankey 1973). This also suggests that brightly colored tents are the most serious problem. The color of equipment is also more important in places with long vistas (such as Alaskan tundra) than in places where visibility is limited (such as eastern forests).
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Common.
COSTS TO VISITORS	Low. The only loss to visitors is one of stylishness and brightness. On a gloomy day, a bright blue and yellow tent can add a little cheer. And perhaps a stylish red parka can make a person look or feel more attractive. But most of this is a matter of taste, which can be quite transitory. There is no significant cost in the form of decreased comfort, convenience, or impact on activity. Most safety concerns can be addressed by carrying some bright orange flagging and/or a mirror.
SPECIAL SITUATIONS	Major exceptions are the increased safety provided by bright equipment for winter camping (to improve visibility during inclement weather) and bright clothes during hunting season (to decrease the likelihood of being shot). Bright equipment during winter is not a problem because the likelihood of encounters is generally low. Bright equipment during hunting season is a problem that must be resolved by choosing safety (bright clothes) over reduced crowding.

PRACTICE 2- CARRY APPROPRIATE EQUIPMENT

DESCRIPTION	Certain equipment items can be helpful in reducing impacts. The most commonly suggested items are a small stove, a fire blanket, tents with poles and waterproof floors, trashbags, trowel, soft-soled shoes for around camp, hammock, and large water container. Items not to carry are more controversial. These items do not necessarily cause problems; they increase the potential for impact. Suggestions include cans and bottles, axes and saws, guns, lug-soled boots, radios and tape players, wire, and nails.
SAMPLE MESSAGES	<p>"Carry a backpacking stove; stoves do not scar the landscape as campfires do. Repackage foods from boxes, bottles, and cans into plastic bags to save weight and space. Leave canned and bottled food home. Empty bottles, cans, and aluminum foil must be packed home. Take a trash bag or two to pack out your garbage-and litter that others may have left behind. A lightweight shovel, trowel, or ice axe will help you dispose of human waste." (8)</p> <p>"Carry a collapsible water container to reduce the number of trips between water sources and your campsite." (86)</p> <p>"Take lightweight soft shoes for around camp. Leave radios and tape players at home." (54)</p> <p>Leave your axe at home. They leave unnatural, unnecessary scars on trees and add weight to your pack. Seasoned users have found them to be unnecessary because of the abundance of downed wood." (58)</p> <p>Use a hammock for sleeping to minimize ground cover damage." (90)</p>
PROBLEMS ADDRESSED AND RATIONALE	(1) Excessive campsite deterioration. Tents with poles and waterproof floors make it unnecessary to cut down trees for tent poles or to excavate a ditch around the tent. A portable stove makes a campfire unnecessary (Berger 1979), or at least reduces the dependence on local firewood supplies. Waterbags reduce the number of trips between campsite and water supply, minimizing the formation of undesired trails. Hammocks reduce ground cover damage, as may use of soft-soled shoes (Harlow 1977; Waterman and Waterman 1979). <i>Not</i> carrying axes and saws reduces the likelihood of scarring trees and logs around campsites. As long as fires are built with wood that can be broken by hand (practice 44), axes and saws are unnecessary for gathering firewood. Stock parties may want to carry these for clearing trail. (2) fitter. Carrying trashbags makes it easier to avoid littering and to pack out other people's litter. <i>Not</i> carrying food in cans, bottles, or even aluminum foil reduces the likelihood that these items will be left behind as litter. (3) Human waste. A trowel is useful in properly disposing of human waste. (4) Visitor conflict. <i>Not</i> bringing a radio or tape player reduces the chance that your noise will disturb others. A radio/tape player with earphones is another option.
IMPORTANCE	Ranges from high to low. Carrying a stove is probably most important. Use of a stove is critical to reducing the impacts of fire scars on campsites and the reduction of wood supplies around campsites. The other items make it more convenient to avoid causing impact.
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Ranges from common for carrying a stove to rare for carrying a hammock and not carrying axes and saws.

COSTS TO VISITORS

Low. None of these items are either prohibitively expensive or heavy. The items not to bring will actually decrease weight. None of these substantially reduce convenience and some increase convenience. The proportion of visitors carrying gas stoves has increased dramatically in recent years (Lucas 1985) to where it is probable that a majority of overnight users carry a stove.

SPECIAL SITUATIONS

Rafts, and to a lesser extent canoes and kayaks, have the ability to carry specialized and often heavy equipment designed to minimize impact. The most common and important is a fire pan, a piece of equipment that minimizes the ecological impact of campfires and facilitates the disposal of charcoal and ash. A box for carrying out charcoal and ash further reduces the esthetic impact of campfires. Finally, portable toilets of varying degrees of sophistication have become an increasingly common means of dealing with problems of human waste at popular campsites (Hampton and Cole 1988). Information on how to acquire this equipment is available from agencies that manage many of the more popular whitewater rivers.

PRACTICE 3- KEEP PARTY SIZE SMALL

DESCRIPTION	Keep the number of people in your party as few as possible, but remember that visitors traveling alone take more risk.
SAMPLE MESSAGES	<p>"Limit your party size. Large groups tend to have more impact than you would expect from increased numbers alone (for example, social trails developing between tent sites)." (42)</p> <p>"Groups larger than 10 people traveling together are discouraged. This size wears out campsites by compacting soil, destroying ground cover, and using up available wood supplies, and their gregarious behavior tends to destroy the wilderness solitude of others visiting the area. Plan your trip with only a few companions." (45)</p>
PROBLEMS ADDRESSED AND RATIONALE	<p>(1) Excessive deterioration of campsites. Large parties require large campsites. Reducing party size would allow campsites to be smaller, provided that efforts are taken to rehabilitate and keep campers off peripheral parts of campsites (Marion and Sober 1987). (2) Proliferation of trails and campsites in little-used areas. Large parties will not necessarily cause more impact to established campsites large enough to accommodate the party; however, they will cause more rapid impact to previously undisturbed places (Hammit and Cole 1987). Therefore, small parties are critical to avoid the creation of new campsites and trails in little-used places. (3) Visitor conflict. Encountering a large party has been shown to do more to diminish feelings of solitude than encountering the same number of people in small parties (Stankey 1973). This suggests that smaller party sizes would eliminate a potential source of visitor conflict. Large parties can reduce their impact by traveling and camping as several smaller groups and by avoiding places without constructed trails and well-established campsites (practice 6).</p>
IMPORTANCE	Moderate. Should be very effective in reducing problems with dissatisfaction from encountering large groups, but its effects on ecological problems are likely to be less dramatic than many assume. The effectiveness of reduced party sizes in reducing resource damage is greatest where impact is likely to occur quickly (for example, in fragile areas, in little-used and relatively undisturbed areas, and where parties travel with stock). Limits on party size must be quite low (certainly no larger than 10) to be worthwhile. Current limits on party size-25 was the most common limit in 1980 (Washburne and Cole 1983)-are often so high as to be virtually meaningless.
CONTROVERSIAL ELEMENTS	Attempts to supply a specific recommended limit on party size have been widely divergent. Recommendations ranged from "4-6" to "less than 15." Aside from the general recommendation to keep party size small, the most common recommendation was "no more than 10." There is little basis for any recommendation beyond the general one to keep size as small as possible. Once a party exceeds a certain number (perhaps four to six), special care must be taken in off-trail travel, campsite selection, and avoidance of visitor conflict.
KNOWLEDGE NEEDS	Although not critical to evaluating the appropriateness of this suggestion, more information on the effects of various party sizes on the visitor experience and on resources would be useful. Research might be able to more precisely identify thresholds in group size that either result in perceived conflict between groups or that cause particularly rapid ecological impact. Such thresholds would certainly differ between backpackers and parties with stock. Of parties of the same size, those with stock would tend to cause more social and ecological impact.
FREQUENCY OF RECOMMENDATION	Common. Regulations limiting party size are also widespread (Washburne and Cole 1983).

COSTS TO VISITORS

Low for most parties. Median party size is usually about three; in nine western backcountry areas, only about 6 percent of parties were larger than 10 persons (Lucas 1980). Costs would be high for those parties who prefer or must travel in large groups (for example, outfitted or organized groups). Such costs could be reduced by condoning large parties, but recommending that they break up into small groups of four to six people to travel, that they disperse locally in camping areas and take care not to enlarge established sites, and that they use well-established routes and destinations.

SPECIAL SITUATIONS

In grizzly bear country it is safer to travel in groups of four or more. There is little advantage to a very large group, but parties of less than four are more likely to surprise a bear and less likely to repulse an attack (Hampton and Cole 1988; Herrero 1985).

PRACTICE 4- AVOID TRIPS WHERE AND WHEN SOILS ARE WET AND MUDDY

DESCRIPTION	Avoid visiting places during seasons when soils are water saturated. The season during and immediately after snowmelt is the most important time to avoid, particularly by parties with stock (Price 1985).
SAMPLE MESSAGES	<p>"If trails are muddy following spring snowmelt, give them time to dry out before your trip. Then you will not have to wade through the mud and chum up the trail surface, making it rough for others to follow." (8)</p> <p>"If possible, plan your trip to avoid the wet soil conditions common early and late in the season." (12)</p>
PROBLEMS ADDRESSED AND RATIONALE:	(1) Deterioration of trails, (2) creation of undesired trails, and (3) deterioration of grazing areas. Trails and meadows (or other places frequently trampled by stock) are particularly susceptible to deterioration when soils are water saturated (Cole 1987b). Constructed trails can be damaged easily and unwanted trails can develop spontaneously (fig.1A). The temporal distribution of wetness can be both unpredictable (as in the case of sporadic thunderstorms) and predictable (as in the case of the season immediately following snowmelt). Staying out of the wilderness during seasons when soils are predictably wet will reduce deterioration of trails and grazing areas. Certain places are more prone to these problems than others. This is particularly important when traveling with stock.
IMPORTANCE	Low to high. In places that are seasonally wet, but relatively durable at other times, avoiding use during wet seasons can reduce impact substantially. In places where wetness is prolonged or unpredictable, or where durability is low even when soils are dry, this practice is less important. It is most critical for stock parties in mountainous areas in the West.
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	Improved information on unfavorable seasons, variation in seasonality from year to year, and places that are particularly prone to problems with seasonal wetness and communication of this information to users would make it easier for users to comply. At Sequoia and Kings Canyon National Parks, parties with stock are not allowed until after an opening date (when conditions have dried out) that varies with general climatic conditions for that year and with the specific places to be visited. Monitoring data have indicated where and when early season stock use is a problem. Opening dates are decided on well before the season starts, to give parties a chance to plan their trips (DeBenedetti and Parsons 1983). Similar programs of information and recommended opening dates could be implemented, relying on voluntary compliance rather than regulation.
FREQUENCY OF RECOMMENDATION	Rare.
COSTS TO VISITORS	Low to moderate. Most visitors will not have to alter their behavior because many areas do not have pronounced and predictable wet and dry seasons. Where wet and dry seasons are pronounced and predictable, most visitation occurs during dry seasons. Substantial costs are borne only by those who cannot shift trips to less-vulnerable seasons.

PRACTICE 5- AVOID TRIPS WHERE AND WHEN ANIMALS ARE PARTICULARLY VULNERABLE TO DISTURBANCE

DESCRIPTION	Avoid visiting places at times when animals are likely to be adversely affected by your visit (for example, when they are giving birth or are weak).
SAMPLE MESSAGE	None.
PROBLEMS ADDRESSED AND RATIONALE	Harassment of wildlife. Animals are particularly vulnerable to disturbance at certain times of the year (Ream 1979). For example, the consequences of fleeing, when scared by an approaching human, are often more pronounced during birthing season (when young may be left vulnerable to predation) and winter (when animals are already stressed and attempting to minimize unnecessary activity) than during midsummer.
IMPORTANCE	Uncertain. To the extent that harassment is a problem, this practice would be an effective means of minimizing problems. To evaluate importance, we need more information on the vulnerability of animals at different times of the year.
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	Current knowledge is so poor that we are seldom able to provide specific behavioral suggestions. Consequently, this recommendation is of little practical value. We need to know more about impacts of recreationists on animals and seasonal differences in vulnerability. Many different animal types from varied regions and ecosystems should be studied.
FREQUENCY OF RECOMMENDATION	No examples were found.
COSTS TO VISITORS	Low to moderate. Most visitors will not have to alter their behavior. Costs may be most pronounced for crosscountry skiers, where animals are particularly vulnerable during winter. Again, we need more information.

PRACTICE 6- AVOID OFF-TRAIL TRAVEL UNLESS PREPARED TO USE EXTRA CARE

DESCRIPTION	When traveling off trail, it is particularly important to take care to avoid impact. Route selection and traveling behavior (practices 19-22), and campsite selection and behavior (practices 27,34-36) require more thought and time. Large parties and parties with stock should avoid off-trail travel unless they are willing to be extremely cautious. Traveling on trails will minimize all problems except excessive encounters and human waste.
SAMPLE MESSAGE	"The impacts associated with cross country travel are minimized when group size is small, routes are carefully selected to avoid fragile terrain and critical wildlife habitat and special care is taken to avoid disturbance." (30)
PROBLEMS ADDRESSED AND RATIONALE	(1) Development of undesired user-created trails. Constructed trails are already highly disturbed, and in many cases have been designed to accommodate heavy use. Leaving trails introduces the risk of creating undesired trails. The potential for this is minimized if parties are small, travel on foot, and select dispersed and durable routes. (2) Animal harassment. Off-trail travel, by accessing relatively undisturbed places, increases potential for disturbance of animals that have sought out remote places. (3) Proliferation of campsites. The potential for creation of new campsites is also high because off-trail travel provides access to relatively undisturbed places. Again, this simply means that special care is needed.
IMPORTANCE	High. If only those parties capable of and committed to practicing minimum impact visited off-trail areas, it would be possible to avoid problems in these places.
CONTROVERSIAL ELEMENTS	Some low-impact materials recommend that hikers avoid trails entirely. This seems unwise unless concern for avoiding visitor contact problems on trails is given a much higher priority than all other problems. Increased off-trail travel will increase contact in places where those encounters are likely to be much more disruptive than along trails.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Rare.
COSTS TO VISITORS	Low. Most visitors choose to travel on trails and most visitors who do travel off trail are experienced and capable of minimizing their impact. Most costs are borne by large groups and parties with stock that wish to travel off trail but are not willing to exert the special care required. These visitor costs are low compared with the benefits of reduced impact, however.

General Conduct

PRACTICE 7- KEEP PETS UNDER RESTRAINT OR LEAVE THEM AT HOME

DESCRIPTION	Where pets are allowed (they are prohibited in all National Parks and in some backcountry areas managed by other agencies), they should be kept under vocal or physical restraint (leashed).
SAMPLE MESSAGES	<p>“Keep dogs under control at all times; they disturb wildlife, hikers, and campers.” (5)</p> <p>“You may bring dogs into the BWCA, but respect other visitors’ rights. Keep dogs on a leash while on portages and prevent excessive barking.” (58)</p>
PROBLEMS ADDRESSED AND RATIONALE	(1) Visitor conflict. Dogs can disturb other visitors (Waterman and Waterman 1979). Unrestrained dogs on trails can spook stock, creating problems. (2) Animal harassment. Unrestrained dogs can also chase and harass animals. These problems can be minimized by leaving highly aggressive dogs at home and keeping all dogs under restraint.
IMPORTANCE	Low to moderate. There is little evidence that pets are a major source of conflict or wildlife disturbance. Keeping them under restraint can effectively minimize problems that do occur. For many dogs, carrying a moderately heavy backpack is an effective means of controlling them on the trail. Restraint at campsites is most important where other parties are camped close by. This problem can be reduced by seeking out more isolated campsites when traveling with pets.
CONTROVERSIAL ELEMENTS	Recommendations that all pets be left at home are increasingly common. While this would be even more effective in eliminating this source of problems, it unnecessarily eliminates a traditional use of wilderness that many visitors value highly. The problems that result from travel with pets are minor compared with those that result from travel with stock, for example. Therefore, as with stock, it seems more appropriate to seek means of permitting use but reducing negative consequences. Pets are already prohibited in National Park wilderness.
KNOWLEDGE NEEDS	We need more information on visitor conflict related to pets and the significance of impacts on animals.
FREQUENCY OF RECOMMENDATION	Common.
COSTS TO VISITORS	Low. Visitors with pets must accept more responsibility for those pets. This may mean more time and effort restraining them, but these efforts need not be substantial. Using a dog backpack would lighten pack loads, and seeking out campsites away from other parties is generally recommended behavior anyway. Only those owners with highly aggressive animals that should be left at home must forgo anything. Even these owners will probably have a more enjoyable experience because they need not worry about conflict.

PRACTICE 8- BE QUIET IN THE WILDERNESS

DESCRIPTION	Avoid making loud noises, such as by yelling or playing recorded music.
SAMPLE MESSAGE	‘Stay as quiet as possible and enjoy the quietness.’ (54)
PROBLEMS ADDRESSED AND RATIONALE:	(1) Too many encounters. Making loud noises makes it more likely that other parties will know you are there. This will tend to reduce solitude. (2) Visitor conflict. Of more importance, loud human noises are often considered to be inappropriate in wilderness. Encounters with parties acting in ways deemed to be inappropriate can lead to serious conflict and perceived crowding problems (Manning 1986).
IMPORTANCE	High. This behavior is less important where there are no other parties around; however, loud noises may also disturb wildlife.
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Common.
COSTS TO VISITORS	Minimal.
SPECIAL SITUATIONS	The major exception to this practice is in areas with grizzly bears. There it is important to make noise, particularly while traveling, to alert bears to your presence. That gives them time to move away without confrontation (Hampton and Cole 1988; Herrero 1985).

PRACTICE 9- MINIMIZE DISTURBANCE OF NATURAL FEATURES

DESCRIPTION	Try to 'leave things as they are.' Avoid unearthing rocks, picking wildflowers, and cutting or uprooting trees and other plant life. Use restraint when gathering edible plants and animals to avoid long-term depletion.
SAMPLE MESSAGES	<p>'Leave rocks and flowers where you find them so others can enjoy them as you do. Minimize disturbance of stones, soil, and plant life, so as not to disturb the conditions in which plants and animals live.' (86)</p> <p>"Please do not dig up plants, pick wildflowers, or cut branches from live trees." (80)</p> <p>"Enjoy an occasional edible plant, but be careful not to deplete the surrounding vegetation or to disturb plants that are either rare or do not reproduce in abundance (such as many edible lilies)." (30)</p>
PROBLEM ADDRESSED AND RATIONALE	This practice addresses concern with recreational impacts in general, without reference to any specific location such as trails or campsites. Disturbance is most concentrated along trails, around campsites, and at attraction sites.
IMPORTANCE	High. Although this practice is quite general, it is an attitude that is critical to avoidance of unnecessary disturbance.
CONTROVERSIAL ELEMENTS	Although this attitude is accepted in principle, it is not always applied to standing trees, both dead and alive, which are often cut down for tent poles or firewood.
KNOWLEDGE NEEDS	The vulnerability of edible plant and animal populations to harvesting is poorly understood. Information on species and places with high vulnerability is needed.
FREQUENCY OF RECOMMENDATION	Common.
COSTS TO VISITORS	Low. Some activities (picking wildflower bouquets, collecting edible plants) may be curtailed. Desired campsites may need to be bypassed if they require removal of rocks or vegetation. Parties may have to carry self-supporting tents and forgo the comfort of large wall tents; they may have to search further for downed firewood and reduce their wood consumption. But all of these inconveniences affect few users in small ways.

PRACTICE 10- DO NOT DISTURB CULTURAL ARTIFACTS OR ARCHEOLOGICAL SITES

DESCRIPTION	Historical and archeological sites should not be disturbed. Cultural artifacts should not be removed.
SAMPLE MESSAGE	“(Archaeological sites) are not renewable and cannot be replaced. Look, photograph, enjoy. But do not disturb. Climbing in, on or around ruins will speed up destruction of the site. Touching rock art will leave oils from your skin on the rock, these oils hasten the deterioration of the art work. Do not remove artifacts! Give someone else the chance to experience the thrill of discovery as you have. It is also against the law. Have respect and appreciation for the time and energy these ancient inhabitants put into their work. It has survived for hundreds of years. Help us preserve it for future generations.” (74)
PROBLEM ADDRESSED AND RATIONALE	Maintenance of cultural and historical artifacts and sites.
IMPORTANCE	High. These practices are critical to the preservation of this element of heritage.
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Uncommon.
COSTS TO VISITORS	Low. The ability to explore sites may be inhibited, and visitors must resist the desire to remove artifacts. But these are relatively insignificant to the wilderness experience and necessary if others are to have similar opportunities.

PRACTICE II- AVOID HARASSMENT OF ANIMALS

DESCRIPTION	Visitors should avoid approaching animals if it causes them to flee, particularly where this causes animals to abandon sites where they give birth or water sources, feeding grounds, or shelter, particularly when they are weak.
SAMPLE MESSAGES	<p>"Observe animals from a distance -do not disturb." (86)</p> <p>"Respect the needs of. . . animals for undisturbed territory. When tracking wildlife for a photograph or closer look, stay downwind, avoid sudden movement, and never chase or charge any animal. [Taking these precautions] is particularly important at birthing or nesting sites and at watering or feeding grounds, especially during times of year, such as winter, when animals are already stressed Find out as much as you can, before entering the area about species, places and times when disturbance is likely." (30)</p>
PROBLEM ADDRESSED AND RATIONALE	Harassment of animals. Numerous case studies have documented situations in which animals have been disturbed by the intrusion of recreationists. (For annotated bibliographies, see Boyle and Samson 1983; Bromley 1985; Ream 1980.) Birds can abandon nests, leaving eggs vulnerable to predation; large mammals forced to flee in winter can find it difficult to find food to replace lost calories. While these studies show that problems exist, we know little about how serious or prevalent these problems are.
IMPORTANCE	Uncertain. It is a truism that this general recommendation is an effective means of avoiding harassment. What is not clear is what specific behaviors are effective or where and when these behaviors are important. It is probable that only certain species are highly susceptible to disturbance and, even for these species, potential for disturbance is confined to certain critical habitats and seasons. But we do not know which species are vulnerable or when and where harassment is particularly damaging. One partial exception is bighorn sheep. Research has shown that bighorn sheep are more profoundly disturbed by hikers with dogs and hikers who approach from over a ridge than by those without dogs and those who remain below (MacArthur and others 1982). Thus, in bighorn country harassment can be reduced by not bringing dogs and by keeping to valley bottoms. More research into and presentation of information of this type is needed to make this practice effective.
CONTROVERSIAL ELEMENTS	None, except that we do not know enough to agree about where and when disturbance is a substantial problem and what sorts of behavior are most appropriate.
KNOWLEDGE NEEDS	For many, the presence of abundant wild animals is synonymous with high-quality wilderness. And yet, except for a few species such as the grizzly bear, we know nothing about how they react to recreationists. Information is inadequate on most aspects of recreation-wildlife encounters and appropriate behavior for minimizing disturbance. We need to learn about 'how serious impacts are; where and when they occur; the susceptibility of different species, at different seasons and places; and how amount, frequency, timing, and type of use, as well as visitor behavior, influence amount of impact. Moreover, because answers to these questions will be somewhat unique to each area, research must be conducted in a variety of places.
FREQUENCY OF RECOMMENDATION	Rare. Usually quite general (and of little practical value) when included at all.
COSTS TO VISITORS	Low to moderate. Most visitors will not have to alter their behavior. Costs include not visiting or not camping in certain critical places at certain critical times and not approaching animals to get a better view or a photograph. By carrying a telephoto lens and/or binoculars, visitors can view wildlife from a distance.

PRACTICE 12- DO NOT FEED ANIMALS

DESCRIPTION	Do not give animals food. This also applies to either accidentally or deliberately leaving food scraps behind (see practice 53).
SAMPLE MESSAGE	"Feeding wild animals produces numerous undesirable effects. It creates unnatural, unbalanced populations which become dependent on unnatural foods. This causes increased susceptibility to disease, and unnatural stresses within the population. Serious personal injury from the larger animals may result as they lose their fear of man. Please-help maintain a natural, balanced ecosystem-don't feed them." (86)
PROBLEM ADDRESSED AND RATIONALE	Disturbance of feeding habits. Feeding of animals can alter animal nutrition and behavior and, ultimately, population structure and distribution.
IMPORTANCE	Low to high, varying greatly between species. Not feeding animals is critical for species that tend to be attracted to and scavenge human food. For bears, feeding can cause behavioral changes that ultimately result in their having to be destroyed. For many other species, the effect of feeding on habits is negligible compared to other sources of disturbance.
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Uncommon, except in the National Parks.
COSTS TO VISITORS	Low. Some enjoyment derived from feeding animals, such as squirrels and jays, must be forgone.

PRACTICE 13- PROTECT FOOD FROM ANIMALS

DESCRIPTION	Store food, either overnight or when away from camp, in such a way that animals cannot get it. Hanging food away from bears is particularly important.
SAMPLE MESSAGE	<p>"Getting your week's supply of food ripped-off by a bear is bad enough. But if the bear should smell the raisins you have stashed in your sleeping bag, and you are also in the bag, you could get injured. In bear country the rule is: Hang all your food in a tree at night, at least 8 feet off the ground, and at least 4 feet out on a small limb. Then camp well away from the food." (14)</p> <p>Similar recommendations could be developed for other animals (such as rodents) that can get into food.</p>
PROBLEM ADDRESSED AND RATIONALE	Disturbance of feeding habits. If animals develop an affinity for human food, their behavior and distribution change. When this happens with bears, problems can be particularly severe because problem bears frequently must be destroyed.
IMPORTANCE	Low to high, varying among species. Most animals are little affected by food storage techniques; however, for the grizzly bear, proper food storage may be critical to their survival.
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Uncommon. Almost always confined to concern with bears.
COSTS TO VISITORS	Low. Some additional time and preparation are required, primarily for gathering together and hanging food. Research on an informational program on food storage techniques to reduce bear depredation at Yosemite National Park suggests that visitors have difficulty translating this knowledge into behavior. While 95 percent of visitors received a brochure on proper techniques, and 92 percent believed they were properly storing food, checks of actual behavior found only 3 percent storing their food properly (Graber 1986).

Backcountry Travel

PRACTICE 14- AVOID WALKING ON CLOSED TRAILS AND/OR DEVELOPING USER-CREATED TRAILS

DESCRIPTION	In places where undesired user-created trails are developing, or where trails have been closed to use, they should not be used. Either walk on open constructed trails or walk off trail some distance away from the developing or closed trails. This may be difficult in popular places where user-created trails are proliferating. Here it may be best to treat one trail as the officially sanctioned one and confine use to that trail.
SAMPLE MESSAGES	<p>"[In areas without established trails] don't follow trampled paths." (86)</p> <p>"Cross country travel is undesirable where user-created trail systems are developing. . ." (30)</p> <p>When you step off a trail make sure that you are the first to do so in that spot. If you can see the tracks of one other person, you will be contributing to trail cutting, erosion, and vegetation loss." (71)</p>
PROBLEM ADDRESSED AND RATIONALE	Development of undesired trails. Low levels of trampling are capable of causing substantial impact (Bell and Bliss 1973; Cole 1985; and others). Therefore, incipient paths are likely to deteriorate quickly if use continues and closed trails will not recover if use continues (fig.1A).
IMPORTANCE	High. The primary cause of unwanted trails is too many people following the same route off trail. If developing and closed trails were strictly avoided, problems with trail proliferation would be minimal.
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Rare.
COSTS TO VISITORS	Low to moderate. Places where user-created trails are developing, or established trails have been closed, are often attractive routes or destinations. Costs to visitors of having to avoid these areas can be reduced by providing access on established trails to the same or comparable places.

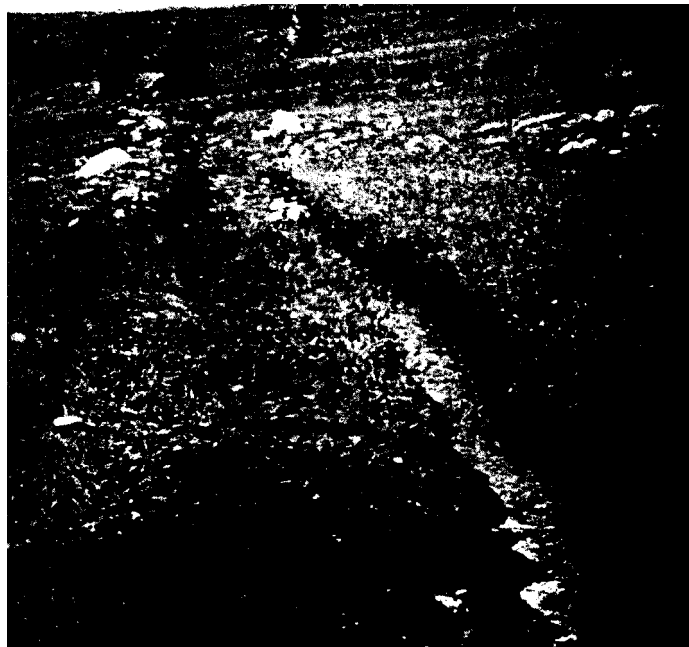
PRACTICE 15- WALK SINGLE FILE AND KEEP TO THE MAIN TREAD

DESCRIPTION	When following an existing trail, walk single file down the middle of the trail. Do not walk on the side of the trail. If there are several braids to the trail, stay to the main tread even if the footing is bad. Do not walk on developing parallel trail treads.
SAMPLE MESSAGES	Walk single file in the center of the trail. Stay on main trail even if wet or snow-covered.” (54) “Always stay on the trail, even if it’s wet and muddy. Don’t step off to the side; that will create a new trail, which will soon become wet and muddy, so people will start stepping off to the side, cutting a new trail . . . This is one of the prime causes of the multiple trails that create a freeway look in the backcountry.” (25)
PROBLEM ADDRESSED AND RATIONALE	Deterioration of constructed trails. Where trails are muddy, snow covered, or deep and narrow, people are tempted to leave the main trail to find better footing. As illustrated in figure1B, this creates either a single wide tread or a stretch of multiple parallel trails (Price 1985). To avoid these problems, hikers and horseback riders need to resist the temptation to leave the main tread. They also should walk single file to minimize the lateral spread of traffic.
IMPORTANCE	Moderate. Trail widening and the development of multiple trails are two of the more common trail deterioration problems (Cole 1987b). They result entirely from lateral spread of trail use and therefore can be eliminated if hikers and stock users keep to the center of the established tread This practice can eliminate these problems (and therefore must be considered highly effective); however, these problems are not among the most significant in wilderness, in that they do not substantially compromise either the integrity of wilderness ecosystems or the quality of wilderness experiences. More effective solutions to this problem, where trails are muddy or deep and narrow, are improved trail location and engineering (Price 1985).
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Common.
COSTS TO VISITORS	Moderate. The primary costs are muddy boots and forgoing walking side by side. For stock users, the only cost is the effort and skill it takes to keep stock single file and on the muddy or narrow trail.



A

Figure 1-Trail problems and appropriate low-impact practices. (A) Meandering systems of user-created trails develop in popular destination areas. Avoid walking on either closed trails or developing user-created trails (practice 14). (B) Muddy trails that widen into quagmires and/or become systems of braided trails are a common problem. Important practices include avoiding trips where and when soils are wet and muddy (practice 4) and, if on a muddy trail, walking single file down the main tread (practice 15). (C) To reduce the likelihood of creating undesired user-created trails, cross-country hikers should spread out (practice 19). Hikers should not mark their route (practice 20) and should select a route that crosses durable surfaces (practice 21).



B



C

Figure 1 (Con.)

PRACTICE 16- DO NOT SHORTCUT SWITCHBACKS

DESCRIPTION	When approaching a trail switchback, stay on the trail. Do not follow a shorter route between trail levels.
SAMPLE MESSAGE	<p>"Never short-cut switchbacks." (54)</p> <p>"Shortcutting switchbacks on steep trails damages soil and plants, leading to severe erosion problems. Switchbacks are designed and built into trails on steep terrain to minimize erosion and to conserve your energy as well." (86)</p>
PROBLEM ADDRESSED AND RATIONALE	Deterioration of constructed trails. Shortcuts between switchbacks usually erode severely. This can also cause erosion of and deposition on the constructed trail.
IMPORTANCE	Moderate. This practice, if followed, would virtually eliminate the problem of erosion of switchbacks. This problem, however, is not one of the most serious in the backcountry. Therefore, the practice is highly effective, but probably not extremely important.
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Very common.
COSTS TO VISITORS	Minimal. The frustration of a stretch of switchbacks is seldom alleviated by shortcutting them. Costs can be reduced through more careful design of switchback trails.

PRACTICE 17- TAKE TRAILSIDE BREAKS OFF TRAIL ON A DURABLE SITE

DESCRIPTION	When taking a break along the trail, move far enough off the trail so other parties can pass by without noticing you. Try to select a durable stopping point, such as a rock outcrop, a non-vegetated site, or a site with resistant vegetation.
SAMPLE MESSAGE	“When taking a break along the trail, move off the trail some distance to a durable stopping place. Here you can enjoy more natural surroundings and other parties can pass by without contact. Durable stopping places include rock outcrops, sand, other non-vegetated places and sites with durable vegetation, such as dry grasslands.” (30)
PROBLEMS ADDRESSED AND RATIONALE	Too many encounters. Allowing other parties to pass without being aware of another party in the vicinity will increase perceived solitude. Selecting a durable stopping point will avoid unnecessary disturbance of natural features.
IMPORTANCE	Low to moderate. This practice will not eliminate problems with frequent trail encounters, but it can reduce them somewhat.
CONTROVERSIAL ELEMENTS	This action could lead to substantial off-trail disturbance if visitors are not careful to minimize disturbance at their stopping point.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Rare.
COSTS TO VISITORS	Minimal. The cost of more time spent seeking an appropriate stopping point should be more than compensated for in the increased solitude and appreciation of the natural environment.

PRACTICE 18- STEP OFF THE TRAIL, DOWNSLOPE, WHEN ENCOUNTERING A STOCK PARTY

DESCRIPTION	To avoid spooking horses along a trail, hikers need to (1) move off the trail, (2) preferably on the downhill side, (3) avoid sudden movement, and (4) sometimes talk to the lead rider in a low voice. If you have a pet, make sure the animal is restrained and quiet.
SAMPLE MESSAGE	Horses are easily spooked by strange sights and sounds. When hikers and riders meet along the trail, bucking horses and possible injuries to riders can be avoided if hikers will step off the downhill side of the trail, stand still, and speak softly until the horses pass." (8)
PROBLEM ADDRESSED AND RATIONALE	Visitor conflict. This behavior is a common courtesy extended by hikers to stock users. It avoids one source of conflict between these two groups.
IMPORTANCE	Moderate. This is another practice that is important in the sense of being a simple means of avoiding a problem for some users (those with stock that spook easily). It is not so important in the context of avoiding situations that seriously compromise overall wilderness objectives.
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Uncommon (perhaps common in places with substantial amounts of stock use).
COSTS TO VISITORS	Minimal.

PRACTICE 19- SPREAD OUT WHEN WALKING OFF TRAIL

DESCRIPTION	When walking off trail, a group of people should spread out and not follow in each other's footsteps (fig. 1C). When selecting a cross-country route, select routes that permit people to spread out.
SAMPLE MESSAGE	'If you choose a route without trails . . . a group should spread out rather than walk one behind the other (especially in tundra or meadow areas). Ten people tramping in a row can crush plant tissue beyond recovery and create channels for erosion.'" (6)
PROBLEM ADDRESSED AND RATIONALE	Development of undesired usercreated trails. Even infrequent trampling can destroy plants and create an incipient trail (see, for example, Cole 1985). Once recognizable, incipient trails attract additional use, and the end result is a pronounced trail. To avoid initiating this chain of events, it is important to minimize the number of times any plant is trampled. The key is for hikers to spread out. This will dilute the trampling impact of a group of people, hopefully enough to avoid damage. This is particularly important with a large party. Sometimes topography and vegetation tend to force single-file travel; such places should be avoided when selecting off-trail routes.
IMPORTANCE	Low to high. Importance varies with use levels and the priority placed on maintaining areas in a trailless condition. As use levels increase in trailless areas, spreading out and avoiding developing trails becomes increasingly important.
CONTROVERSIAL ELEMENTS	None. .
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Uncommon.
COSTS TO VISITORS	Low to moderate. Where terrain and vegetation are open and gentle, spreading out is easy. In other cases, however, there is a single path of least resistance. It can be difficult to avoid this route. Often such a route has already been affected by game traffic.

PRACTICE 20- DO NOT MARK CROSS-COUNTRY ROUTES

DESCRIPTION	When traveling off trail, do not mark the route with cairns, tree blazes, or in any other way. Let the next party find their own way.
SAMPLE MESSAGE	"Avoid leaving your mark (cairns or blazes) when bushwhacking or traveling cross-country. Leave it as undisturbed as possible, so that the next group will have the same experience of traveling through trail-less country." (23)
PROBLEM ADDRESSED AND RATIONALE	Development of undesired usercreated trails. Where trails have not been constructed, spontaneous trail development should be discouraged. This requires minimizing use of cross-country routes. Blazing or marking routes will encourage further use of that route, leading ultimately to trail development. It also conflicts with objectives of minimizing unnecessary disturbance of natural features and evidence of human use.
IMPORTANCE	High. Maintaining trailless areas in wilderness is one of the more difficult challenges facing management. Marking of routes will eliminate any chance of avoiding trail development, except in places where use levels are negligible. Therefore, this practice is very important in maintaining the undisturbed qualities of trailless areas that are receiving use.
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Uncommon.
COSTS TO VISITORS	Minimal. The only conceivable cost is having to rediscover the route on a later tip.

PRACTICE 21- CHOOSE A CROSS-COUNTRY ROUTE THAT CROSSES DURABLE SURFACES

DESCRIPTION	When walking off trail, attempt to walk, as much as possible, on surfaces that will not be disturbed by trampling, such as nonvegetated surfaces, snow, or rock.
SAMPLE MESSAGE	<p>"If you strike out away from trails, select rocky or hard ground or forested routes rather than meadows and wet places. Then, like the way of the Indians, your tracks will not be visible." (8)</p> <p>"[When traveling in areas without trails] walk on snow and rock where safe." (42)</p> <p>"If you wish to explore off-trail you are welcome to do so. Travel on slickrock and in dry washes leaves no trace of your passing." (71)</p>
PROBLEM ADDRESSED AND RATIONALE	Development of undesired user-created trails. Durable surfaces can be walked over more frequently than fragile surfaces before an evident trail develops. The keys to avoiding trail development, then, are minimizing use frequency and maximizing surface durability. In general, surfaces that are dry, stable, and nonvegetated are most durable. Where off-trail routes keep to such surfaces as bare rock, ice and snow, sand- and gravel-covered riverbeds or washes, and nonvegetated forest floors, even moderate use can leave no trace. But relatively infrequent use of routes that cross steep and unstable slopes, moist and boggy areas, or places with lush and fragile vegetation will cause trail development. When considering appropriate routes through vegetation, both vegetation density and durability should be considered. Trails will develop more slowly in sparse vegetation, except where the plants that make up the cover are particularly fragile (a common situation underneath forest canopies). Some of the more durable vegetated types include those with virtually no ground cover, those with abundant large shrubs and little ground cover, and dry grasslands and meadows (Cole 1987b; Kuss 1986).
IMPORTANCE	Moderate to high. Importance increases with use level and the importance attached to maintaining trailless areas.
CONTROVERSIAL ELEMENTS	Specific recommendations about durable surfaces are frequently contradictory. This reflects inadequate knowledge about durability and attempts to make inappropriately broad generalizations. More research, more site-specific recommendations, and fewer broad generalizations are needed.
KNOWLEDGE NEEDS	We need more information, for specific places and environments, about the durability of different surfaces, particularly different vegetation types. This will permit the development of specific recommendations for individual areas.
FREQUENCY OF RECOMMENDATION	Uncommon.
COSTS TO VISITORS	Low to moderate. The principal costs are more time needed to select a durable route, as well as possibly avoiding more desirable routes because of fragility concerns. For many visitors these costs would be outweighed by the satisfaction of knowing that they have used their skills and knowledge to avoid creating a trail in an undisturbed area.

PRACTICE 22- USE CAUTION WHEN ASCENDING OR DESCENDING STEEP SLOPES

DESCRIPTION	When it is necessary to ascend or descend steep slopes off trail, special care is needed to avoid severe erosion. It is important to spread out and avoid developing trails, to switch-back, to move slowly, and to avoid digging boots into the slope.
SAMPLE MESSAGE	"In mountainous areas, follow the backbones of gradual ridges instead of cutting down steep side slopes. If you must hike on a steep slope, make your own switchback as you ascend and descend Do not glissade down gravel or scree slopes." (26)
PROBLEM ADDRESSED AND RATIONALE	Development of undesired user-created trails. Steep slopes are often particularly vulnerable to trail development (Weaver and others 1979). Therefore, it is important to minimize use and the impact caused by each hiker. Spreading out dilutes the trampling stress; moving slowly, switchbacking, and not digging boots into the slope reduce the impact of trampling.
IMPORTANCE	Moderate to high. Importance increases with use level. Where use is sufficient to result in trail development, this practice is critical to avoidance of severe erosion.
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Rare.
COSTS TO VISITORS	Low to moderate. It can be difficult to resist following a developing trail rather than spreading out. It also is often tempting to rapidly descend slopes, particularly where they are gravel and scree slopes.

Campsite Selection and Behavior

PRACTICE 23-IN POPULAR LOCATIONS, SELECT A WELL-IMPACTED CAMPSITE

DESCRIPTION	This recommendation applies to consistently used destination areas, as opposed to places where camping occurs infrequently. In such places, choose a campsite that already has experienced substantial impact (fig. 2B). Do not select a previously unused or lightly impacted site.
SAMPLE MESSAGE	'[In areas with trails and established campsites] camp in an established site so as to prevent the spread of bare areas." (86)
PROBLEM ADDRESSED AND RATIONALE	Proliferation of campsites. In places that receive consistent camping use, use of previously unused and lightly impacted sites is likely to lead to the creation and deterioration of new campsites. Sites that are already well impacted, if used with care, need not deteriorate substantially over time (Cole 1986a). Impacts are confined to these sites instead of being allowed to proliferate (Marion and Sober 1987).
IMPORTANCE	High. Not selecting sites that already are well impacted is the primary cause of ongoing campsite deterioration problems in popular destination areas (Cole 1986a). Moreover, this is among the most pervasive recreation management problems in wilderness (Washburne and Cole 1983). Therefore, it is of critical importance. Where not heeded, destination areas will be afflicted with numerous unnecessary and highly disturbed sites (see, for example, Cole 1982a).
CONTROVERSIAL ELEMENTS	Some have recommended that well-impacted campsites be avoided. While this recommendation is appropriate in remote places (see practice 24), it will cause widespread campsite impact in popular places. This is a case where what is appropriate in one situation is to be avoided in others. Attempts to make universal generalizations are counterproductive.
KNOWLEDGE NEEDS	Controversy about whether to use well-impacted or previously unused sites will not be resolved by research; it is a question of defining different situations in which each strategy is more appropriate. Research could perhaps help define more precisely the situations in which each strategy is appropriate.
FREQUENCY OF RECOMMENDATION	Common.
COSTS TO VISITORS	Low. Visitors must camp on sites that are already highly impacted. Most wilderness campers select such sites by habit (Cole 1982a Heberlein and Dunwiddie 1979). Visitors who do prefer more pristine environments can simply visit more remote and little-used places.

PRACTICE 24- IN REMOTE LOCATIONS, SELECT A PREVIOUSLY UNUSED CAMPSITE

DESCRIPTION	When looking for a campsite in places away from trails or where camping occurs infrequently, select a site that shows no evidence of having been used before.
SAMPLE MESSAGE	"[When in areas without trails and established campsites] camp where there is no evidence that others have camped before." (86)
PROBLEM ADDRESSED AND RATIONALE	Proliferation of campsites. In places where overnight use is infrequent, careful use of durable sites need not cause disturbance (fig. 2A). The key idea behind this action is to minimize use frequency. If sites are not camped on after disturbance becomes evident, they should still be capable of recovering rapidly. Widespread dispersal and rotation of use between sites prevent any site from deteriorating substantially. For this strategy to be successful, however, use levels must be quite low. This action must also be accompanied by careful selection of a durable site (practice 27) and extra care in avoiding and camouflaging disturbance (practices 29-31, 34-36).
IMPORTANCE	High. This practice is critical to avoiding the development of established campsites in relatively undisturbed areas. It will be successful only when applied in places where use levels are low. In more popular areas, this practice is likely to result in proliferation of campsites (see, for example, Cole 1982a); in such places practice 23 (select a well-impacted campsite) is more appropriate.
CONTROVERSIAL ELEMENTS	Some low impact materials recommend that all camping be confined to well-impacted campsites. While this recommendation is appropriate in popular places (see practice 23), it will cause unnecessary campsite impact in infrequently used places. This is a case where what is appropriate in one situation is to be avoided in others. Attempts to make universal generalizations are counterproductive.
KNOWLEDGE NEEDS	Controversy about whether to use well-impacted or previously unused sites will not be resolved by research; it is a question of defining different situations in which each strategy is more appropriate. Research could perhaps help define more precisely the situations in which each strategy is appropriate.
FREQUENCY OF RECOMMENDATION	Uncommon.
COSTS TO VISITORS	Low to moderate. Visitors must avoid obvious, established campsites. Presumably, most visitors in the more remote portions of the wilderness would value the less disturbed environment, but considerably more care in site selection and use is required. Those preferring traditional established campsites have the option of visiting more frequently used and heavily impacted places.
SPECIAL SITUATIONS	Many wilderness areas, particularly those managed by the National Park Service, prohibit camping except on designated campsites. One should always adhere to regulations of the managing agencies.

PRACTICE 25- NEVER CAMP ON A LIGHTLY IMPACTED CAMPSITE

DESCRIPTION	Avoid camping on an obviously disturbed but lightly impacted campsite (such as one in which there is obvious vegetation loss, but only on a small portion of the site [fig. 2C]). It is more appropriate to camp either on a more heavily impacted site (in popular places) or on a site with no evidence of use (in remote places).
SAMPLE MESSAGE	"Lightly impacted sites-those that have obviously been used but with a substantial amount of vegetation surviving on-site should always be avoided; such sites will deteriorate rapidly with further use, while if unused they should recover rapidly." (30)
PROBLEM ADDRESSED AND RATIONALE	Proliferation of campsites. Lightly impacted campsites are on the verge of becoming permanent, well-impacted sites; continued use will cause this deterioration. If their use is curtailed, however, they still are capable of recovering. Therefore, it is better to camp on heavily impacted sites-where the most severe damage has already occurred-or on undisturbed sites that are capable of supporting infrequent use without deteriorating (Cole and Benedict 1983).
IMPORTANCE	High. This practice is critical to avoiding widespread campsite proliferation in popular destination areas and unnecessary campsite impact in relatively undisturbed places. In both situations there are more appropriate sites to select for camping.
CONTROVERSIAL ELEMENTS	Some low-impact materials suggest that visitors should select lightly impacted campsites. This recommendation appears to ignore the research findings that campsites at this stage of deterioration are most vulnerable to further deterioration with continued use (Cole 1987b).
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Rare.
COSTS TO VISITORS	Low. More appropriate sites are always available.



A

Figure 2- Campsite impacts and appropriate low-impact practices. (A) In remote locations, it is most appropriate to camp on a previously unused site (practice 24). It is also important to select a durable site (practice 27) to spread out tents and activities (practice 34) to keep lengths of stay short (practice 35) and to camouflage any disturbance (practice 36). (B) In popular locations, it is most appropriate to camp on a well-impacted site (practice 23). It is also important to select a site that is large enough to accommodate your party (practice 26) to select a concealed campsite (practice 28) to confine tents and activities to already impacted areas (practice 32) and to leave the site clean and attractive for the next party (practice 33). (C) tightly impacted sites, like this one, should not be used (practice 25). If the campfire ring is dismantled and the wood and rocks are scattered, this site should recover rapidly. With continued use, however, it will soon deteriorate into a well-impacted campsite.



B



C

Figure 2 (Con.)

PRACTICE 26- SELECT A SITE THAT IS LARGE ENOUGH TO ACCOMMODATE YOUR PARTY

DESCRIPTION	Select an established campsite with an already impacted area that is large enough for your party. It should be possible to locate the kitchen and all sleeping places in areas that are already highly disturbed. Select a larger site elsewhere, rather than risk enlarging the site by camping on its periphery.
SAMPLE MESSAGE	"Large parties and parties with packstock do the most damage and special efforts should be made to encourage them to select sites that already have been substantially altered and are large enough to accommodate their party size" (20)
PROBLEM ADDRESSED AND RATIONALE	Deterioration of established campsites. Most of the deterioration occurring on long-established campsites consists of the outward expansion of zones of impact (Cole 1986a; Merriam and others 1973). This occurs when parties camp on the periphery of sites, either because they choose to camp there or because they are too large for the site. The former cause can be alleviated by more carefully confining activities (see action 33); the latter cause is the one addressed by this action.
IMPORTANCE	Moderate to high. Site expansion is among the most serious campsite impact problems, and improper sits selection is one of the causes of site expansion. But most parties naturally tend to seek out sites large enough to accommodate their group.
CONTROVERSIAL ELEMENTS	N o n e .
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Rare.
COSTS TO VISITORS	Low to moderate. Most parties are small enough to be unaffected by this concern. Where campsites are few and far between, this practice may require traveling and searching more than a large party wants. This cost could be reduced by planning in advance to camp in places likely to have large campsites available. Managing agencies could also provide large parties with specific directions to suitably sized campsites.

PRACTICE 27-SELECT A DURABLE SITE

DESCRIPTION	<p>Select a site that is durable enough so that your stay will not cause impact. Durability concerns differ between well-impacted sites and previously unused sites. Selecting a durable site is generally more important on unused sites; on well-impacted sites, the potential for damage has already been reduced by previous impact. Flat sites, without vegetation or easily disturbed soils, are always preferable. Selection of a site with durable vegetation is most important on previously unused sites. On well-impacted sites, vegetation will be lost regardless of durability; durable sites are those that have little erosion potential and have either thick organic horizons or unconsolidated mineral soil (Cole 1987a). Sleeping and cooking areas can be separated; cooking can be done on highly durable sites (such as rock slabs) that might be uncomfortable sleeping places.</p>
SAMPLE MESSAGES	<p>'Avoid locating campsites in areas that have delicate plants." (33)</p> <p>"Choose a site on sandy terrain or the forest floor, rather than the lush, but delicate plant life of meadows, streambanks, fragile alpine tundra, and other areas that can be easily trampled or scarred." (6)</p> <p>"Camp on snow or gravel rather than on vegetation; or select a site which is covered by dry sedge rather than heather, huckleberry or other less-resilient plants." (76)</p>
PROBLEMS ADDRESSED AND RATIONALE	<p>(1) Deterioration of established campsites. Well-established campsites in durable locations are less likely to experience excessive deterioration than those in fragile locations. The most common severe-impact problems related to site durability are erosion and exposure of highly compacted mineral soils; therefore, preferred sites include those with thick organic horizons and those in sand and gravel, with low erosion potential. (2) Proliferation of campsites. Durability is even more critical when selecting a previously unused site for camping. Durable sites can be camped on more frequently than sensitive sites before deterioration becomes obvious and additional users are attracted to the developing campsite. Vegetation loss is the most evident initial change on previously unused sites. Therefore, previously unused sites with a durable vegetation cover are preferred where it is not possible to select a site without vegetation.</p>
IMPORTANCE	<p>Moderate to high. This practice is extremely important on previously unused sites in places where use levels are not extremely low. It is among the most important means of avoiding the creation of new campsites. It is somewhat less critical either in very lightly used places or in places with well-established campsites.</p>
CONTROVERSIAL ELEMENTS	<p>The concept of using resistant sites is not disputed; what constitutes a durable site is controversial, however. Attempts to make broad generalizations, without recognizing differences between established and previously unused sites or between different environments, result in contradictory recommendations. Resolution of controversies will require additional research, as well as a willingness to recognize that this issue is complex.</p>
KNOWLEDGE NEEDS	<p>There is a sizable literature on site durability (see Cole 1987b) and Kuss 1986 for an introduction). We need more information, however, for specific places and environments. This would permit the development of more specific recommendations such as those in sample message 76.</p>
FREQUENCY OF RECOMMENDATION	<p>Common. Many low-impact messages provide some do's and don'ts about durable places to camp. But there is little agreement on recommendations and less specificity than is desirable.</p>
COSTS TO VISITORS	<p>Low to moderate. The principal costs are the additional time required to search for a campsite that is resistant to impact, as well as desirable for other reasons, and forgoing camping on desirable sites that are fragile. For many visitors, these costs will be outweighed by the satisfaction of knowing that they have used their skills and knowledge to minimize impact. Moreover, many durable sites have characteristics that make them particularly desirable (for example, well-drained, rather than muddy or dusty).</p>

PRACTICE 28- ELECT A CONCEALED CAMPSITE AWAY FROM TRAILS, OCCUPIED CAMPSITES, LAKES, AND OTHER WATER BODIES

DESCRIPTION	Locate your campsite where it is not likely to be observed by others walking or camping in the area. Locate it away from trails, occupied campsites, water bodies, and "beauty spots" that attract others. Concealed locations behind large boulders, in or behind clumps of trees, and on benches above lakes are ideal. In low-use places, this action is less important than selecting a durable campsite. In these places it may be preferable to select a durable open campsite instead of a more fragile forested site.
SAMPLE MESSAGES	<p>"You will enjoy more solitude and be less conspicuous if you select a campsite away from the favorite spots. Locate your camp 200 feet or more from lakes, streams, meadows, and trails. Camping next to a busy trail or in full view of lakes, streams, and in meadows robs others of an unmarred scene and a feeling of solitude." (8)</p> <p>"If other parties are close to where you want to camp, move on or choose your campsite so that terrain features ensure privacy. Trees, shrubs, or small hills will reduce noise substantially. Try to camp at least 200 feet away from water sources, trails, and beauty spots' to prevent water and visual pollution." (6)</p>
PROBLEMS ADDRESSED AND RATIONALE	<p>(1) Too many encounters. When selecting a campsite, it is important to locate a site where both ecological impacts and impacts on other campers are minimized. This action is primarily concerned with minimizing encounters between parties. By camping in places that are "out of the way," away from trails and other parties, and away from attractions, including lakes and other water bodies, contacts can be reduced (Echelberger and others 1983). They can also be reduced by selecting sites that are concealed by local topography and vegetation.</p> <p>(2) Animal harassment. In deserts, particularly, camping next to a waterhole can keep animals from water vital to their survival. (3) Water pollution. Arguments for locating campsites away from water bodies to avoid damaging fragile lakeshores and polluting water have intuitive appeal. There is little evidence, however, that lakeshores are particularly fragile (Cole 1982b) or that pollution from lakeshore camping is a serious problem (see, for example, Silverman and Erman 1979). There may be some places where camping close to water causes pronounced pollution. The primary justifiable rationale for asking people not to camp on lakeshores, however, is that this will tend to reduce encounters and preserve the esthetic qualities of lakeshores—a limited and highly valued resource (Cole 1981).</p>
IMPORTANCE	Low to high Importance varies with use levels and the nature of local topography and vegetation. In places where there are no other parties, this practice is not important (except where animals might be disturbed). In contrast, this practice is very important in destination areas with numerous parties. It can increase campsite solitude substantially, and campsite solitude is extremely important to many visitors (Manning 1986). It is also more important in environments with open vistas and few concealed sites.
CONTROVERSIAL-ELEMENTS	There is little controversy about the recommendation. Some controversy exists about the rationale for recommendations not to camp on lakeshores. So far there is little definitive evidence that camping on lakeshores causes more serious or unique ecological impact problems than camping away from lakeshores. Unless this evidence can be found, it would be better to rely on social rationales that can be more easily justified.
KNOWLEDGE NEEDS	The value of this recommendation is based on the assumption that campers value campsite solitude more highly than they value being able to camp on traditional campsites close to trails and attractions such as lakes. This assumption is open to debate and could be tested. More research on water pollution adjacent to places where lakeshore campsites are located could resolve controversy over the underlying rationale for this recommendation.
FREQUENCY OF RECOMMENDATION	Very common. This is among the most common of recommendations.
COSTS TO VISITORS	Moderate. At first, costs could seem high because many campers will be forced to camp away from preferred campsites. Traditional campsites may have to be bypassed, with more time spent in campsite selection. But benefits in terms of campsite solitude should offset these costs, perhaps creating new norms for preferred campsite locations.

PRACTICE 29- WEAR SOFT-SOLED SHOES AROUND CAMP

DESCRIPTION	When you arrive at camp, take off lug-soled boots and put on soft-soled shoes such as tennis shoes or moccasins.
SAMPLE MESSAGE	Wear sneakers or moccasins in and around the campsite. Heavy-soled shoes have a great impact on the ground cover. Besides, your feet deserve the rest.“ (90)
PROBLEMS ADDRESSED AND RATIONALE	(1) Deterioration of established campsites and (2) proliferation of campsites. Wearing soft shoes around camp may reduce deterioration both of established and previously unused campsites, if these shoes have less impact on vegetation and soil.
IMPORTANCE	Low. All studies to date have found little difference in the impact caused by different types of shoes (Russ 1983; Saunders and others 1980; Whittaker 1978). Although there may be differences in some situations, they are unlikely to be substantial.
CONTROVERSIAL ELEMENTS	Although there is no controversy, the common belief that soft shoes are less damaging than lug-soled boots is not supported by research. But because costs to visitors are low, there are no likely ecological side-effects, and there may be some situations where consequences are beneficial, the recommendation to wear soft shoes can be supported.
KNOWLEDGE NEEDS	More research on the effects of different shoe types might identify situations where types differ in their impact. It might also more precisely define the importance of this practice.
FREQUENCY OF RECOMMENDATION	Uncommon.
COSTS TO VISITORS	Low. Soft shoes add weight and take up space, but not much. Having a change of shoes also offers advantages of comfort and safety.

PRACTICE 30- MINIMIZE INTENTIONAL SITE ALTERATION AND THE BUILDING OF STRUCTURES

DESCRIPTION	Avoid intentionally altering the campsite and building structures. Activities to avoid include moving rocks and logs, digging up vegetation, digging ditches around tents, and building such structures as tables, chairs, and hitch rails. If you do some landscaping and construction, be prepared to dismantle and camouflage it (actions 33 and 36). Never leave wire and nails.
SAMPLE MESSAGES	<p>“Campcraft (rock wind screens, wood construction, trench lines around tents, etc.) is not only unnecessary, but it is also extremely destructive. Pick a well-drained campsite and use a tent with waterproof floor or a waterproof groundcloth so trenching won’t be necessary.” (86)</p> <p>“Avoid trenching around your tent, cutting live branches, or pulling up plants to make a parklike campsite. If you do end up clearing the sleeping area of twigs or pinecones, scatter these items back over the campsite before you leave.” (6)</p>
PROBLEMS ADDRESSED AND RATIONALE	(1) Deterioration of established campsites and (2) proliferation of campsites. Engineering, landscaping, and construction of structures cause unnecessary impact to campsites, whether they are well established or virtually unused. These actions can cause further impact (such as where ditching causes accelerated erosion), they create eyesores and unnecessary evidence of human alteration, and on lightly used sites they can encourage increased use, which ultimately leads to campsite proliferation.
IMPORTANCE	Moderate. These impacts, while highly obtrusive, are generally not irreversible. This practice could, however, eliminate an entire category of unnecessary impacts.
CONTROVERSIAL ELEMENTS	There is some difference of opinion among users over the appropriateness of building facilities. While some users like to construct structures of various kinds, most wilderness users prefer primitive campsites (Stankey and Schreyer 1987); constructed facilities are major sources of visitor dissatisfaction (Lee 1975). There is little controversy, however, over the conclusion that these activities should be minimized in wilderness.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Very common;
COSTS TO VISITORS	Low. Landscaping and construction may offer some additional comfort and convenience, but they are unnecessary.

PRACTICE 31- AVOID TRAMPLING VEGETATION

DESCRIPTION	When walking around on or sitting in the campsite, note surviving clumps of vegetation and avoid disturbing them. Avoid trampling tree seedlings in particular. Walking routes and the location of tents or kitchen areas can be adjusted to make it easier to stay off surviving vegetation (see action 32 as well).
SAMPLE MESSAGE	" . . . watch where you walk to avoid crushing vegetation." ". . . try not to step on tree seedlings." (30)
PROBLEMS ADDRESSED AND RATIONALE	(1) Deterioration of established campsites and (2) proliferation of campsites. Where vegetation is sparse, either naturally or as a result of previous impact, vegetation loss can be minimized by being careful to step between rather than on plants. Survival of tree seedlings is critical to the long-term maintenance of forested campsites. Tree seedlings are quickly eliminated by trampling; therefore, special attention must be given to not stepping on them.
IMPORTANCE	Moderate. Efforts to not step on vegetation can be helpful in many situations, but where use is heavy or vegetation is dense, benefits are limited. This practice is most important (1) on previously unused sites where the vegetation is sparse and not highly resistant and (2) on established sites where tree seedling survival is limited.
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Rare.
COSTS TO VISITORS	Low. Some concentration is required at first, but soon watching where you step requires little thought. The location and nature of activities are unaffected.

PRACTICE 32- ON ESTABLISHED CAMPSITES, CONFINE TENTS AND ACTIVITIES TO ALREADY IMPACTED AREAS

DESCRIPTION	Locate tents and a central kitchen area in places that have already lost their vegetational cover. The general idea is to confine trampling, as much as possible, to places that have already been highly disturbed by trampling (fig. 2B).
SAMPLE MESSAGE	When you camp at a well-marked site, you try to make most use of the ground that is already bare, already stamped by human presence; a little more traffic won't alter it further. When paths and pads are there, use them. But avoid doing anything to extend the barren area." (1)
PROBLEM ADDRESSED AND RATIONALE	Deterioration of established campsites. Expansion of zones of disturbance is the most common long-term deterioration problem on backcountry campsites (Cole 1986a). This practice seeks to avoid expansion by concentrating use on already impacted portions of the site. On-site concentration complements the strategy of selecting an already impacted site, as opposed to an undisturbed site.
IMPORTANCE	High. Well-impacted campsites are undesirable to many wilderness users. In popular places they are inevitable. Impact levels on established campsites should be kept to a minimum, however. Avoiding expansion is perhaps the most important means of limiting deterioration, and onsite concentration of activities is critical to avoiding expansion of impact.
CONTROVERSIAL ELEMENTS	On previously unused sites, the opposing strategy-dispersing tents and activities-is more appropriate (practice 34). Attempts to make simple generalizations about traffic flow and activity location on campsites that apply everywhere are inevitably contradictory. The general concept of concentrating use in already disturbed places and dispersing use in undisturbed places should not be controversial.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Uncommon.
COSTS TO VISITORS	Low. Assuming that a large enough (practice 26) well-impacted (practice 23) campsite has been selected, it should be a simple matter to confine activities to already disturbed portions of the site. This is probably almost instinctive behavior.

PRACTICE 33- ON ESTABLISHED CAMPSITES, DISMANTLE ANY STRUCTURES YOU BUILT AND ANY OTHER INAPPROPRIATE STRUCTURES; LEAVE THE SITE CLEAN AND ATTRACTIVE

DESCRIPTION	Dismantle any structures that were built. (As noted in practice 30, such construction should generally be avoided.) Structures built by others should also be dismantled, if they are inappropriate and not likely to be immediately rebuilt. Leave a single firering (but dismantle any additional rings) and any agency-built structures. Primitive log seats should probably also be left, and there are situations where user-built stock facilities should be left. The basic philosophy is to keep facilities to a minimum, but to avoid having them rebuilt on different parts of the site, spreading impact around. This requires striking a balance between the ideal goal of having no 'permanent' facilities and the practical value of confining the impact associated with a facility to a small area. It is also important to leave the site clean and attractive so that other parties will be attracted to the site, rather than use some less appropriate site.
SAMPLE MESSAGE	"When leaving camp, make sure that it is clean, attractive and will be appealing to the next group to use the area. . . . It is appropriate to. . . dismantle inappropriate user-built facilities, such as multiple firerings, constructed seats, tables, etc. However, properly-located and legal facilities, such as a single firering in many areas, should be left. Dismantling them will cause additional impact, because they will be rebuilt, with new rocks, and impact a new area" (30)
PROBLEM ADDRESSED AND RATIONALE	Deterioration of established campsites. The basic idea is to leave the campsite as attractive as possible so that other parties will want to camp on the site. This encourages concentration of use and impact. Therefore, it is important to (1) remove facilities that are considered inappropriate by others, but leave those that will certainly be rebuilt (primarily a rock firering and perhaps a sitting log) and (2) clean up the site, particularly pick up litter (practices 51 and 53) and clean up the firering (practice 49). Most visitors find a simple rock firering to be a desirable feature of an established campsite (Stankey and Schreyer 1987).
IMPORTANCE	Moderate. This practice effectively reduces impact, but those impacts are not irreversible.
CONTROVERSIAL ELEMENTS	Some people suggest that all facilities should be dismantled, regardless of the circumstances. This suggestion seems counterproductive where facilities will simply be rebuilt and impact a larger portion of the site. Stock facilities are particularly controversial. They are unnecessary, suggesting that they should be dismantled; however, the fact that they are frequently rebuilt suggests that it might be better to leave them. Perhaps dismantling of such facilities should be left to agency personnel.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Rare.
COSTS TO VISITORS	Low. The time spent dismantling facilities and cleaning up the site, the primary cost, should not be great and will be offset by having clean and attractive sites to camp on.

PRACTICE 34 -ON PREVIOUSLY UNUSED SITES, DISPERSE TENTS AND ACTIVITIES

DESCRIPTION	Set tents up some distance from each other and from the central kitchen area. Stay off the site as much as possible and disperse your activities. Take alternate paths to water and minimize the number of trips. A portable water container makes this easier. Do everything possible to minimize the number of times that any place or path is trampled. This practice, the opposite of practice 32- the appropriate behavior on well-impacted sites-complements the strategy of selecting previously unused sites in remote places.
SAMPLE MESSAGES	<p>'If you are at a pristine site, most especially if there is vegetation underfoot . . . try to avoid repeated traffic over any one piece of ground. In moving between kitchen and spring, or tent and toilet area, take a slightly different route each time, and try to walk on duff, rocks, and mineral soils. Try not to mill around too much in one place, as at the entrance of the tent or in the cooking area" (1)</p> <p>"Arrange your site to avoid concentrating activities in the cooking area. Carry water to your site in large containers so fewer trips are needed. Further reduce your impact by choosing a different route each time you go for water." (90)</p>
PROBLEM ADDRESSED AND RATIONALE	Proliferation of campsites. To avoid creation of a campsite, it is important to minimize the number of times any piece of ground is trampled. Spreading out tents, activities, and traffic routes, along with selection of a previously unused site, helps realize this goal. Even a large party can avoid causing substantial impact if they locate their tents some distance from each other and avoid congregating in one place (unless that place is highly resistant- such as bare rock).
IMPORTANCE	Low to high. Where camping occurs on a virtually indestructable surface (such as bare rock, snow, or a beach), this practice is of little concern. It becomes increasingly important, however, as site durability decreases and as use levels increase.
CONTROVERSIAL ELEMENTS	On well-impacted sites, the opposing strategy-confining tents and activities to already impacted portions of the site-- is more appropriate (practice 32). Attempts to make simple generalizations about traffic flow and activity location on campsites that apply everywhere are inevitably contradictory. The general concept of concentrating use in already disturbed places and dispersing use in undisturbed places should not be controversial.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Uncommon.
COSTS TO VISITORS	Low. More attention needs to be paid to where you walk. This is part of the reason that using remote places and previously unused sites requires more care than using popular, well-impacted campsites and places. With time, this requires little thought, and this practice does not require significant changes in locations or behavior.

PRACTICE 35- IN PREVIOUSLY UNUSED SITES, KEEP LENGTHS OF STAY SHORT

DESCRIPTION	'Minimize the amount of time spent on the site. In many situations, sites should not be camped on more than 1 night. Never stay so long that disturbance is pronounced.
SAMPLE MESSAGE	'Spend no more than a night or two at any site, to give plants a chance to recover." (86)
PROBLEM ADDRESSED AND RATIONALE	Proliferation of campsites. This practice, along with practices 24 (in remote locations, select a previously unused campsite) and 34 (spread out tents and activities), works to minimize the number of times any single piece of ground is trampled. This will limit deterioration and the likelihood that a campsite will develop.
IMPORTANCE	High. It is important that previously unused sites are not used for too many nights in a row. If they are, damage will be evident and further use is likely to be attracted to the site. Keeping lengths of stay to an absolute minimum may be less important, particularly where use levels are very low and sites are highly durable.
CONTROVERSIAL ELEMENTS	The concept is not controversial; however, there have been some inevitable contradictions in attempts to state exactly how many nights of use is acceptable. This maximum will vary with use frequency and site durability. Most low-impact materials suggest that lengths of stay should be limited on established campsites, as well as on previously unused sites. This is not necessary as long as other low-impact practices are followed (traffic is confined to devegetated places and site engineering and facility construction are avoided).
KNOWLEDGE NEEDS	More helpful information on appropriate lengths of stay could be provided if we had more research on deterioration rates of previously unused campsites. Such rates will vary with environmental characteristics, however, making a simple universally applicable limit an impossibility.
FREQUENCY OF RECOMMENDATION	Uncommon. Moreover, most recommendations have been applied to established campsites where this action is less important.
COSTS TO VISITORS	Moderate. This can require more frequent moving than desired. This is one of the costs of the extra care required to visit remote areas. Sometimes costs can be reduced by moving, but staying in the general area

**PRACTICE 36- ON PREVIOUSLY UNUSED SITES, CAMOUFLAGE ANY
DISTURBANCE**

DESCRIPTION	Make every effort to camouflage any inadvertent disturbance. Twigs, cones, and duff can be scattered on places where organic horizons have been scuffed up. Broken vegetation can be picked up and scattered elsewhere, while flattened vegetation can sometimes be "fluffed up." Fire sites in particular should be carefully camouflaged (action 50).
SAMPLE MESSAGE	'Before leaving camp, naturalize the area. Replace rocks and wood used; scatter needles, leaves and twigs on the campsite.' (34)
PROBLEM ADDRESSED AND RATIONALE	Proliferation of campsites. Camouflaging disturbance is a way to avoid encouraging further use of the site. Any evidence that a place has been used as a campsite seems to attract repeat use. This practice is intended to minimize evidence of use.
IMPORTANCE	Moderate. Camouflaging disturbance is important; however, if other low-impact practices were followed, there should be little camouflaging required.
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Uncommon.
COSTS TO VISITORS	Low. Some time must be spent, but not much. This is another of the costs associated with use of remote places.

Campfires

PRACTICE 37 LIMIT THE USE OF CAMPFIRES

DESCRIPTION

Always question whether or not you really need or want a campfire. It is almost always better to cook on a stove, and esthetic fires are often not needed every night or can be limited to a short period of time. Work toward reducing the frequency and duration of campfires.

SAMPLE MESSAGES

"Fires should be used sparingly, as they are among the most serious visual impacts in the backcountry. Use of stoves is always preferable to building a campfire. Always carry a stove; use it for most if not all cooking; and only build a fire where it is safe and will not cause further damage or deplete wood supplies." (30)

"If possible, avoid building fires. For cooking, a stove is much easier and is far more efficient. Roper equipment, clothing and technique will provide more warmth than a fire. Fires are inadvisable because they sterilize the soil and inhibit growth. They remove materials that continue the decomposition/rejuvenation process and can destroy ground cover. In addition, fires create an artificial barrier between you and the sights, sounds, and smells of the outdoor environment." (23)

PROBLEMS ADDRESSED AND RATIONALE

(1) Deterioration of established campsites and (2) proliferation of campsites. The rationale behind this recommendation is to minimize the impacts associated with gathering firewood and having a campfire. Fewer and shorter fires, whether on well-impacted sites or on previously unused sites, will cause less impact. There will be less visual impact, less reduction of wood supplies! and less impact to the ground around an established fire site.

IMPORTANCE

Moderate. If all other low-impact recommendations on the use of campfires were followed, this recommendation would be unnecessary. This practice is most important (1) where proper fire location, construction, and cleanup practices are not followed and (2) in popular places, where firewood supplies have been depleted (places where fires would not be built if practice 38 was adhered to).

CONTROVERSIAL ELEMENTS

None.

KNOWLEDGE NEEDS

Nothing critical to the basic concept behind this recommendation. A better understanding of the significance of impacts associated with the gathering and burning of wood would improve our perspective on the importance of this action.

FREQUENCY OF RECOMMENDATION

Very common.

COSTS TO VISITORS

Low to moderate. As stated, costs are low. More emphatic statements about avoiding having campfires entirely are much more costly to those who enjoy campfires.

PRACTICE 38- AVOID FIRES WHERE FIREWOOD IS NOT PLENTIFUL

DESCRIPTION	Do not have a campfire in places where little dead and downed wood is available. Lack of firewood can reflect either low natural productivity (for example, close to and above timberline or in deserts) or depletion of wood supplies in popular camping areas. Either camp someplace where firewood is more plentiful or forgo a campfire.
SAMPLE MESSAGE	"You should use a campfire infrequently and only when there is abundant dead wood available on the ground. Be very critical about the necessity for campfires. In many areas, wood is being used faster than it grows. In overcamped areas or near timberline, choose an alternate campsite or use a portable stove." (6)
PROBLEMS ADDRESSED AND RATIONALE	(1) Deterioration of campsites and (2) general disturbance of natural conditions. Gathering wood in places where it is not abundant upsets ecosystem functioning around campsites. Large decaying wood in particular plays an important and irreplaceable role in the ecosystem in water and nutrient conservation and as a substrate for biological activity (Cole and Dalle-Molle 1982). Where gathering of firewood depletes all the downed wood, even large pieces, impact becomes severe. This is a particular problem at timberline and in arid environment, where growth rates are slow.
IMPORTANCE	Moderate. This practice is an effective way of minimizing the impacts associated with gathering firewood. These impacts are usually not particularly widespread, however.
CONTROVERSIAL ELEMENTS	N o n e .
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Uncommon.
COSTS TO VISITORS	Moderate. Campers in popular destination areas and in environments with low productivity may have to forgo campfires. In most cases, however, they retain the option of visiting places where campfires are less detrimental.

PRACTICE 39- DO NOT BUILD A FIRE WHERE FIRE DANGER IS HIGH

DESCRIPTION	Fire danger can be extremely high in certain places, at certain seasons, in particularly dry years, or when winds are high. Fires should not be built during these situations. If there is any question, visitors should check with managing agencies for fire danger or closures.
SAMPLE MESSAGE	"Avoid use of fires when fire hazard is high." (30)
PROBLEM ADDRESSED AND RATIONALE	General disturbance of natural conditions. Obviously, fires should not be built when there is a substantial risk that they could start a wildfire.
IMPORTANCE	High. A wildfire started by a careless camper is one of the more significant impacts of recreational use.
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Rare.
COSTS TO VISITORS	Low. There are relatively few places and times when this should constrain options.

PRACTICE 40- BUILD FIRES ON MINERAL SOIL WHERE TREES, ROOTS, VEGETATION OR ROCKS WILL NOT BE SCARRED

DESCRIPTION	Select a fire site where it is possible to build the fire on mineral soil, rather than on duff, vegetation, or rock. Usually this involves finding an established fire site or a place where mineral soil is exposed or underneath a thin layer of duff that can be removed. It is also possible, with care, to build a fire on a mound of mineral soil placed on rock (see action 45). The fire should also be far enough from trees, roots, overhanging branches, and large rocks so they are not blackened or harmed. Avoid building a fire in dense vegetation.
SAMPLE MESSAGE	"Never build a fire in deep, woody forest duff, on peat, or on humus. Never build one next to a log or tree, next to a clean standing rock, or on vegetation. Instead, find mineral soil of some sort." (1)
PROBLEMS ADDRESSED AND RATIONALE	(1) Deterioration of established campsites and (2) proliferation of campsites. This action seeks to avoid long-term and unnecessary fire scars on rocks, trees, and vegetation. Scars on mineral soil, in contrast, can be scattered and/or covered. The action also seeks to avoid starting a wildfire through burning in duff. Any of these undesired scars can represent unnecessary impact on established campsites or leave long-term evidence of use on previously unused sites. Such evidence can encourage repeat use and the development of a new campsite.
IMPORTANCE	High. Creating a fire scar is perhaps the fastest way to cause long-term impact to a previously unused site. Therefore, building fires on mineral soil (along with careful fire construction and cleanup practices) is critical to avoiding campsite proliferation. It is also an effective means of avoiding unnecessary and unsightly impacts on established campsites.
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Uncommon.
COSTS TO VISITORS	Low. More time may be required to find or create an appropriate location for a fire.

PRACTICE 41- IN PLACES WITH WELL-IMPACTED CAMPSITES, BUILD FIRES IN EXISTING FIRERINGS OR ON FIRE SCARS

DESCRIPTION	When camping in an area that has well-impacted campsites and existing firerings, build campfires in an existing ring, or at least in a place that has already been scarred by fire. Do not build a campfire on a previously undisturbed spot. When selecting among several existing firerings, select one that will make it easy to concentrate onsite activities (practice 32).
SAMPLE MESSAGE	"[In heavily used areas] if fires are permitted, use an existing fire circle rather than build a new one." (8)
PROBLEMS ADDRESSED AND RATIONALE	(1) Deterioration of established campsites. This is an additional aspect of the policy of concentrating use and impact on places that are already well impacted, in this case on a single spot on each campsite where fires have already been built. If this is not done, fire impacts are likely to spread around the site, leaving an unappealing and more highly impacted campsite. (2) Proliferation of campsites. This problem can be avoided by concentrating use and impact on campsites where fires have already been built. Otherwise, campfire impacts will spread to new sites that will likely deteriorate over time.
IMPORTANCE	High. Campfires are among the most common, visually obtrusive, and long lasting of impacts. This practice is critical to limiting the proliferation of campfire scars in popular destination areas. It is also important to keep established firerings clean and attractive (practice 49).
CONTROVERSIAL ELEMENTS	Attempts to make universally applicable rules about either always building fires in existing firerings or building fires on previously unused sites have been contradictory. Use of existing firerings is most appropriate in frequently used areas, while previous fire sites should be rehabilitated and avoided (practice 42) in remote places. The concept is to concentrate use and impact in popular places and to disperse use and impact in little-used places. The controversy results from attempting to develop a single simple rule.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Common.
COSTS TO VISITORS	Low. Existing firerings are the most convenient places to build fires anyway. If campers want to select their own fire site, they have the option of visiting appropriate low-use areas.

PRACTICE 42- IN PLACES WITHOUT WELL-IMPACTED CAMPSITES, DO NOT USE EXISTING FIRERINGS OR SCARS; DISMANTLE ANY RINGS

DESCRIPTION	When in an infrequently used area without well-developed campsites, dismantle and camouflage any firerings that you find. Do not use them and do not camp there. Select a site without obvious disturbance for camping and fire building.
SAMPLE MESSAGE	"If a fire ring shows signs of recovery, such as plant recolonization, you should disassemble the fire ring and camouflage the area so that future camping in the area will be discouraged." (3)
PROBLEM ADDRESSED AND RATIONALE	Proliferation of campsites. This practice complements practice 24 (in remote locations, select a previously unused campsite). A firering serves as evidence of previous impact. It should be avoided, and the fire evidence should be removed so that others will not be attracted to the site. Repetitive use of a lightly impacted site will cause deterioration (Cole 1987b).
IMPORTANCE	Moderate to high. This practice is particularly important where use levels are moderately high-almost to the level where it would be better to concentrate use on a few well-impacted campsites. It is always an important means of avoiding pronounced campfire impacts and the proliferation of campsites.
CONTROVERSIAL ELEMENTS	Some low-impact materials suggest that campfires should always be built in existing rings. This recommendation is appropriate in places with well-impacted sites (practice 41), but it results in unnecessarily impacted and obtrusive fire sites when applied in low-use places. The controversy results from attempting to develop a single universally applicable rule.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Rare.
COSTS TO VISITORS	Moderate. This practice requires visitors in remote areas to take the extra time and care to build fires on a previously unused site. It is always easier to use an existing fire site. Visitors who want the ease of fire in an existing site have the option of visiting well-impacted places.

PRACTICE 43- GATHER FIREWOOD AWAY FROM CAMP; DISPERSE YOUR GATHERING

DESCRIPTION	Walk some distance from the immediate camp area to collect firewood. Gather a few pieces here and there, always leaving some wood on the ground. Do not take the last pieces of wood from any area
SAMPLE MESSAGE	'Gather wood some distance from camp on existing sites and always leave some wood, so the area does not look denuded.' (30)
PROBLEM ADDRESSED AND RATIONALE	Deterioration of established campsites. Dispersal of gathering and a willingness to search some distance from camp can avoid the common situation of an area totally devoid of down wood around frequently used campsites.
IMPORTANCE	Low to moderate. The ecological impact of concentrated firewood gathering may not be severe (Cole and Dalle-Molle 1982), as long as large woody debris is not collected (practice 44). But the esthetic effect is pronounced and can easily be avoided
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	R a r e .
COSTS TO VISITORS	Low. A little more time may be required to collect firewood. By not bothering to search in the picked-over area close to campsites, time is saved, however.

PRACTICE 44- USE ONLY DEAD AND DOWN FIREWOOD THAT YOU CAN BREAK BY HAND

DESCRIPTION	Select firewood from pieces that are dead and lying on the ground. Pieces should be small enough to break in your hands and fit within the fire site. Do not collect wood from standing trees, dead or alive, and do not collect or chop up large pieces of wood. There is no need for an ax or saw.
SAMPLE MESSAGE	"Remember when you gather wood that it must be both dead and down to be eligible. Rooted, rotten snags are not firewood: they are habitat and hunting territory for owls, woodpeckers, and a whole community of animals small and large. Don't use wood you can't break. Axe and hatchet are no part of the wilderness tool kit today." (1)
PROBLEMS ADDRESSED AND RATIONALE	(1) Deterioration of established campsites and (2) general disturbance of natural conditions. Collection of wood that is not dead and down represents unnecessary disturbance of vegetation, which may be important for a variety of animals, particularly cavity-nesting birds. Collection of large pieces of down woody debris causes problems that do not result from the removal of small pieces of wood. Large woody debris plays an important and irreplaceable role in the ecosystem in water and nutrient conservation, as a substrate for biological activity, and in other ways (Cole and Dalle-Molle 1982). The tree components which in the long term are most important to nutrient cycling are the leaves or needles and twigs (Weetman and Webber 1972), so removal of small pieces of wood causes little problem. Hacking of large downed wood and standing wood also causes pronounced esthetic impacts.
IMPORTANCE	Moderate. This practice would be effective in minimizing the impacts associated with the collection of firewood. These impacts are highly localized and probably not among the most critical.
CONTROVERSIAL ELEMENTS	Stock parties in particular tend to bring axes and saws to cut firewood. In fact, an ax is useful for stock parties to chop out trail obstacles. There may be some resistance to the idea of not chopping firewood, despite the fundamental ecological rationale for the recommendation.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Use only dead and down firewood is a very common recommendation. The recommendation to use small pieces that can be broken by hand is uncommon.
COSTS TO VISITORS	Low. Firewood collection should take no longer. Extra time spent in collection will be offset by time saved in chopping wood.

PRACTICE 45- ON PREVIOUSLY UNUSED FIRE SITES, BUILD FIRE IN A SHALLOW PIT OR ON A MOUND OF MINERAL SOIL

DESCRIPTION	<p>Fires should be built either in a shallow pit in mineral soil or on a mound of mineral soil. Mound fires are an appropriate way to have a fire on rock. In neither case should a fire be built where vegetation is dense. For a mound fire, locate a source of sand or mineral soil that will not be disturbed by excavation and redeposition of material. Build the fire on top of a 6-inch-deep layer of mineral soil. For a pit fire, clear any duff or sparse vegetation; dig a shallow pit; and build the fire in this pit. See the example below and Hampton and Cole (1988) for more detail.</p>
SAMPLE MESSAGES	<p>When looking for a potential fire site in a pristine area, . . . choose a surface of mineral soil, thin duff (less than 2-3 inches thick), sparse vegetation, or a flat rock. Never build a fire in thick duff because the danger of fire spreading is great. Avoid fires in dense vegetation because it is difficult to not damage the vegetation."</p> <p>"Fires can be built either on a mound or in a pit. Mound fires are preferable if an adequate supply of sand or mineral soil can be found without damaging the source area."</p> <p>Wound fire: Spread a layer of soil about 6 inches deep on top of the ground surface, over an area larger than the fire will occupy. Build the fire on the soil. Mound fires are most likely to be built on mineral soil, duff, or rock. . . . [When cleaning up], scatter the soil and ash and camouflage the surface with mineral soil or litter and duff (whatever matches the surroundings). If the mound was built on a rock, rinse the rock off."</p> <p>"Pit fire: In mineral soil, simply dig a shallow pit several inches deep. Build the fire in the pit. Where there is a thin duff layer or sparse vegetation, clear the duff down to mineral soil from a circle several feet in diameter; build the fire in a shallow pit in the center of the circle of mineral soil [To clean up, scatter ash], fill [the pit] in, and camouflage the site." (30)</p>
PROBLEM ADDRESSED AND RATIONALE	<p>Proliferation of campsites. Campfire remnants and scars are one of the most obvious signs of human use in remote areas and on little-used sites. They provide unnecessary evidence of human presence and, by encouraging repeat use, contribute to the creation of new campsites. Proper campfire construction, along with careful cleanup on previously unused sites, can minimize these problems.</p>
IMPORTANCE	<p>High. Proliferation of fire scars and campsites in little-used places is one of the more serious unnecessary problems in wilderness. This practice, along with proper campfire cleanup and appropriate campsite selection and behavior, is critical to avoiding this problem. If these practices are followed, campsite impact can be virtually absent from the vast majority of the acreage of most wilderness and backcountry areas.</p>
CONTROVERSIAL ELEMENTS	<p>These specific practices are not controversial. Many educational brochures also describe a technique for building fire in a hole cut in dense vegetation. This technique has a high potential for causing damage and has been abandoned, due to poor success, by the National Outdoor Leadership School (NOLS) (which was largely responsible for developing the original technique). It is covered in the section on practices that can be counterproductive (refer to page 98). Its effectiveness has never been rigorously evaluated. Some areas have regulations that prohibit building fires outside of designated areas or in places where fires have never been built before.</p>
KNOWLEDGE NEEDS	<p>The effectiveness of these construction methods (and the more controversial method for dense vegetation) has never been rigorously evaluated. Evaluative research could improve our ability to precisely state construction specifications and preferred methods.</p>
FREQUENCY OF RECOMMENDATION	<p>Uncommon.</p>
COSTS TO VISITORS	<p>Low to moderate. Proper construction of campfires on previously unused sites requires care and some time and effort. This is one of the costs of using remote sites.</p>

PRACTICE 46- DO NOT RING A FIRE WITH ROCKS

DESCRIPTION	(This practice applies primarily to previously unused sites). Do not build a ring of rocks around the fire. Rocks do not increase fire safety. For cooking, use a stove, a grill with folding legs, or, as a last resort, two rocks to support a grill.
SAMPLE MESSAGE	“Resist the temptation to build a rock fire circle. You may want to use a small rock or two to support cooking pots, but a full circle is not needed and does not prevent fire from spreading.” (8)
PROBLEM ADDRESSED AND RATIONALE	Proliferation of campsites. Blackened rocks are one of the obvious scars left by campfires. Minimizing or avoiding use of rocks limits this problem.
IMPORTANCE	Low to moderate. Provided that other low-impact practices are followed in little-used places, this practice is not critical. It is, however, an effective and easy way to avoid unnecessary impact. This practice is most important where multiple firerings are built on well-impacted sites and where fires are built on undisturbed sites close to well-impacted campsites; however, both of these situations should not exist if practices 23 (in popular locations, select a well-impacted campsite) and 41 (in places with well-impacted campsites, build fires in existing firerings or on fire scars) are followed and campers and managers leave a single clean firering on well-impacted sites (practice 49). Because these other practices are not always followed, and this one entails few costs, it should be encouraged.
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Uncommon.
COSTS TO VISITORS	Low. No change in practices is required.

PRACTICE 47- KEEP FIRES SMALL

DESCRIPTION	Campfires should be small. The area of the fire, size, and amount of firewood should all be minimized.
SAMPLE MESSAGE	"Build small fires-not large warming fires." (7)
PROBLEM ADDRESSED AND RATIONALE	(1) Deterioration of established campsites, (2) proliferation of campsites, and (3) general disturbance of natural conditions. The basic rationale is to minimize the consumption of firewood and the area impacted by campfires.
IMPORTANCE	Low to moderate. This practice increases in importance as demand for firewood increases and supplies of firewood decrease.
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Common.
COSTS TO VISITORS	Low. Small campfires are generally at least as functional as large ones. Desires for large bonfires must be suppressed, particularly in popular places and places where firewood is scarce.

PRACTICE 48- BURN CHARCOAL TO ASH; SOAK ASHES; SCATTER EXCESS FIREWOOD

DESCRIPTION	Toward the end of the fire, stop adding large pieces of wood and concentrate on burning charcoal down to ash. When charcoal has burned to ash, soak the ashes to make certain the fire is out. Ashes should be cool enough to touch with your bare hand. Scatter any excess firewood away from the camp. Then, if you were using an existing fire site, leave the firering clean (practice 49); if you were using a previously unused site, remove all evidence of the fire (practice 50).
SAMPLE MESSAGES	<p>'Stop adding fuel well before you wish to put the fire out. Keep pushing all half-burnt wood into the center of the fire until only white ash remains. Thoroughly soak the entire firepit with water.' (9)</p> <p>"You should not have collected more wood than you needed, but if you have, scatter it also. Diffusion is a major strategy of minimum-impact camping; extra wood should be spread lightly so it will not be noticed." (3)</p>
PROBLEMS ADDRESSED AND RATIONALE	(1) Deterioration of existing campsites. Proper cleanup leaves existing campsites more attractive for the next party. (2) Proliferation of campsites. This practice is most important in avoiding site proliferation. Leaving a fire site clean on an established campsite encourages subsequent use; the next party is less likely to camp elsewhere and disturb another site. On previously unused sites, this practice is one of the first steps in removing evidence of use, thereby avoiding encouragement of further use and eventually the development of new campsites.
IMPORTANCE	Low to moderate, except that soaking is always important as a means of avoiding wildfire. This practice is less important on established campsites.
CONTROVERSIAL ELEMENTS	In some places it is a time-honored tradition to leave a pile of firewood for the next camper. On established sites this may be acceptable, although it is unnecessary and does run counter to the philosophy of leaving little evidence of your stay.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Uncommon.
COSTS TO VISITORS	Low. Some time is required to let the fire burn down, but this is not a burden and no major behavioral changes are required.

PRACTICE 49- ON PREEXISTING FIRE SITES, LEAVE THE FIRERING CLEAN AND ATTRACTIVE; DISMANTLE EXTRA FIRERINGS

DESCRIPTION	When camping on a well-impacted campsite, campfires should be built where fires have been built before. A small, clean fire site should be left. If there was originally a ring of rocks, leave a ring of rocks. If the ring was overly large and built up, excess rocks should be scattered, away from the campsite. If it was clogged with charcoal and ash, this material should also be scattered away from the site. Scatter rocks, charcoal, and ash lightly in a number of places to be as inconspicuous as possible. Other firerings on the site should be dismantled completely. Scatter rocks, charcoal, and ash away from the site and attempt to camouflage the fire scar. Any litter should be carried out.
SAMPLE MESSAGES	<p>"If using a pre-existing fire site, leave a small clean firering to attract the next user. If large quantities of ash were generated by you or previous users, scatter it some distance from the campsite. Any excess blackened rocks from an over-built firering or from multiple firerings- should be returned to their original locations, if possible, or scattered some distance from the camp." (30)</p> <p>"Fire rings have a habit of proliferating around camps. Destroy extra ones by spreading out the rocks, scattering the ashes and covering with soil or duff." (40)</p>
PROBLEMS ADDRESSED AND RATIONALE	(1) Deterioration of existing campsites and (2) litter. Overbuilt, sloppy firerings, extra rings, scattered fire debris, and litter represent significant esthetic impacts. This action seeks to avoid this unnecessary problem. Leaving a single clean ring will tend to confine the impacts associated with campfires by encouraging others to build campfires in that same place. (3) Proliferation of campsites. An attractive site, by encouraging repeat use, also helps avoid the creation of new campsites by users who would choose not to use a campsite littered with firerings, blackened rocks, charcoal, and ash.
IMPORTANCE	High. This is one of the more important practices on well-impacted campsites. Widespread campfire debris and litter are unnecessary impacts that are particularly obtrusive and displeasing to subsequent campers. This practice can eliminate those problems and make camping in frequently used, well-impacted destination areas more pleasant.
CONTROVERSIAL ELEMENTS	Some low-impact materials suggest that all firerings on campsites should be dismantled, regardless of circumstances. On frequently used sites, this frequently results in fire impacts spreading around a site as new firerings are built in different places. As a universal suggestion, dismantling all firerings is not recommended; it is appropriate in remote, little-used places (practice 50).
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Uncommon.
COSTS TO VISITORS	Low. It does take some time to carefully clean out firerings and debris. Time spent will diminish, however, as others learn to behave properly. This time is merely the cost associated with being able to have a campfire.

PRACTICE 50-- ON PREVIOUSLY UNUSED FIRESITES, REMOVE ALL EVIDENCE OF THE FIRE

DESCRIPTION	After having a campfire in a place where fires have not been built before, remove all evidence of the fire. Either a pit or mound fire should have been built. With a pit, simply fill in the pit with excavated mineral soil and camouflage the disturbance with soil or duff-whatever will blend in with the surroundings. With a mound fire, return the ash and soil to its source or scatter it widely. If built on a rock, rinse the rock. Again, camouflage the site. All wood and charcoal should have been burned to ash; if it was not all burned, remove it from the ashes and scatter it widely. Rocks should not have been blackened, but if they were, scatter them widely. Refer to Hampton and Cole (1988) for more detail.
SAMPLE MESSAGE	"If you have been using a firepit, drown the ashes and coals, scatter all remaining ashes, and return most of the mineral soil you removed back to the hole. Now look at the surrounding ground cover, and camouflage the top of the firepit to match. Use duff, aspen leaves, pine cones, whatever it takes to restore the surface to its natural state. Always be careful not to overcamouflage. A big pile of duff is a sure giveaway that there is something underneath. Good camouflaging is an art that takes a subtle touch. If you have built a flat rock (mound) fire, scatter the ashes and return the mineral soil to where you got it. Rinse the rock with water, wash off any remaining residue of soil, and landscape the entire area." (3)
PROBLEM ADDRESSED AND RATIONALE	Proliferation of campsites. Evidence of a campfire can encourage subsequent users to camp at the same spot. Where this happens, campsites develop rapidly. Removing evidence of campfires, along with proper campsite selection and behavior, eliminates this threat.
IMPORTANCE	High. Effective elimination of campfire evidence in remote places is critical to maintaining such places in a virtually undisturbed condition. It is one of the responsibilities that must be accepted when building a campfire in remote places.
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Uncommon.
COSTS TO VISITORS	Low to moderate. This practice requires a commitment of time to mitigate the disturbance caused by campfires. Proper fire site selection and construction can minimize time requirements, however. For those who do not want to take the time, options include not having a campfire and visiting places with well-impacted campsites and established fire sites.

Waste Disposal and Sanitation

PRACTICE 5I- PACK OUT NONORGANIC LITTER (OR BURN READILY BURNED LITTER)

DESCRIPTION	All nonorganic litter should be burned or packed out; it should not be buried or scattered. Paper products, including toilet paper, can usually be burned. Where fires are not permitted, paper products should be packed out, as should cans, bottles, plastic products, and anything else that cannot be completely burned. Special care must be taken to avoid leaving inconspicuous pieces of litter (such as "twist-ties") or the aluminum foil that lines paper products and will not burn.
SAMPLE MESSAGES	<p>"you will want to pack out every bit of garbage that cannot be completely burned. Don't bury it." (7)</p> <p>"The basic rule of waste disposal is to pack out what cannot be otherwise disposed of by careful meal planning. Only waste water and fish viscera should be scattered and burning of waste should be minimized." (30)</p> <p>"Minimize the use of toilet paper. If it is used, either pack it out (ideally) or burn it as completely as possible and bury any remnants. Do not burn toilet paper if fire hazard is high or regulations prohibit it. Tampons should be packed out (unless you are in grizzly bear country) or burned in a very hot fire; they should never be buried." (30)</p>
PROBLEM ADDRESSED AND RATIONALE	Litter. Removing all nonorganic waste products that are brought into the wilderness will eliminate litter problems.
IMPORTANCE	High. Litter is not a long-term ecological impact problem; however, it is one of the more serious problems in the opinion of wilderness users (Roggenbuck and others 1982; Stankey 1973). This practice, if faithfully applied by all users, would eliminate litter problems.
CONTROVERSIAL ELEMENTS	The concept of packing out what you pack in is generally accepted. The handling of toilet paper is controversial, however. Many land managers dislike the idea of burning it because this increases the risk of wildfire; users dislike the idea of packing it out. Burying toilet paper is the less-than-desirable compromise that is often suggested.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Very common.
COSTS TO VISITORS	Low. All this practice requires is that visitors pack out what they pack in, minus what they eat and can bum. Only packing out toilet paper can be undesirable.
SPECIAL SITUATIONS	In grizzly bear country, odorous materials can attract bears. Do not pack out containers that hold odorous material. Through careful pretrip planning, odorous foods should be kept to a minimum and containers that are not burnable should be avoided

PRACTICE 52- PICK UP OTHER PEOPLE'S LITTER

DESCRIPTION	In addition to packing out your own litter, pick up as much of that left by others as possible.
SAMPLE MESSAGE	"Pick up trash left by others and carry the leave no trace" ethic the extra mile-a true 'good turn' for all who enjoy wilderness and the backcountry." (8)
PROBLEM ADDRESSED AND RATIONALE	Litter. This practice will remove some of the litter problem created by unconscientious users.
IMPORTANCE	Low to moderate. This practice can help reduce litter problems, but deals with symptoms rather than the cause. It is less important than practice 51 (packing out your own litter).
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Common.
COSTS TO VISITORS	Low. Even relatively little effort and weight addition can be helpful.

PRACTICE 53- PACK OUT OR BURN ORGANIC GARBAGE (OR SCATTER FISH VISCERA)

DESCRIPTION	Small quantities of organic garbage (food scraps) can be burned in a hot fire. Large quantities are difficult to burn and should be packed out. Do not scatter or bury food scraps; they will attract animals. Fish viscera can be widely scattered, but should not be thrown back in lakes or streams. Packing them out or burning them is better, however.
SAMPLE MESSAGES	<p>"Select low-waste foods and prepare them in quantities that will be eaten completely. If you do have leftover debris, however, pack it out with your other garbage." (23)</p> <p>"Litter and food scraps can be minimized with careful planning and preparation. Food can be carefully measured so leftovers are minimized. When food is left, it should be packaged up and either eaten later or packed out. Partial burning, which is likely to occur when food is burned at the end of a meal, is unacceptable. Fish viscera are generally a natural part of the ecosystem. They should be scattered widely, out of sight and away from campsites. In high-use areas and in bear country they should be scattered a long way from camps. Do not throw viscera back into lakes and streams (unless bear danger is high and viscera can be thrown into deep water); the cool temperatures in most mountain waters prevent rapid decomposition." (30)</p>
PROBLEMS ADDRESSED AND RATIONALE	(1) Litter and (2) disturbance of feeding habits. Both of these problems can be avoided if waste is packed out or completely burned. Widespread scattering may make litter problems unobtrusive; however, it can alter the feeding habits of animals.
IMPORTANCE	Moderate. Organic wastes decompose more rapidly than nonorganic litter and are probably less of a problem in the opinion of wilderness users. This practice is an effective means of minimizing problems, however.
CONTROVERSIAL ELEMENTS	The pack-it-out, burning, and scattering options for disposal can all be found in the literature. Clearly, packing it out is the option most consistent with minimum-impact use; however, the other options are more convenient for users. The recommendations described above represent compromises between <i>convenience</i> and 'doing the right thing.'
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Uncommon.
COSTS TO VISITORS	Low. In all cases, less must be packed out than was packed in.
SPECIAL SITUATIONS	In grizzly bear country, food scraps should not be packed out. Special care in planning is required. Leftovers that cannot be burned should be scattered a long way from camp.

PRACTICE 54- USE TOILETS IF PROVIDED

DESCRIPTION	When camped in an area where toilets are provided, use them. Do not practice the dispersed cathole method (practice 55).
SAMPLE MESSAGE	None found, although the practice is implied in most areas where toilets are provided.
PROBLEM ADDRESSED AND RATIONALE	Human waste. Toilets concentrate human waste in a single place. This should reduce the risk of accidental contamination.
IMPORTANCE	Moderate to high. In places where toilets are constructed, use levels are usually very high. In such places, use of toilets-assuming they are properly located and maintained-effectively minimizes the risk of contamination. The severity of the health risk associated with dispersed catholes is unclear, however. We do know that pathogens are capable of surviving in buried feces for years (Temple and others 1982).
CONTROVERSIAL ELEMENTS	The appropriateness of toilets in wilderness is questioned. Decisions about appropriateness involve tradeoffs between human health and esthetics and the provision of structures.
KNOWLEDGE NEEDS	A better understanding of fecal decomposition rates and the risks of contamination would provide a better basis for evaluating the importance of this practice and the situations in which provision of toilets are or are not needed.
FREQUENCY OF RECOMMENDATION	None.
COSTS TO VISITORS	Low. Many visitors dislike the use of toilets; others prefer using toilets (Stankey and Schreyer 1987). Those who dislike toilets can visit less popular places where toilets are not needed. Providing information on the location of toilets in the backcountry is important.

PRACTICE 55- DISPOSE OF HUMAN WASTE IN A PROPERLY LOCATED CATHOLE

DESCRIPTION	In an area without toilets, human waste should be disposed of in a place where it will not pollute waters and where other people will not find it. Catholes should be widely dispersed, as far from campsites, trails, lakes, and streams as possible. Waste should be buried in a small hole excavated in mineral soil, a place where disturbance will be minimal. Do not simply cover feces with a stone. A small trowel can be helpful. Do not build a latrine (refer to page 99).
SAMPLE MESSAGE	'For individuals, dig small latrines (cat-holes) in the top 6 to 8 inches of soil at least 200 feet from water, camp, and trails. Cover your latrine thoroughly with soil, rocks, needles, and twigs.' (8)
PROBLEMS ADDRESSED AND RATIONALE	(1) Human waste and (2) water pollution. Where toilets are not provided, individuals must be responsible for depositing waste in a manner and place that minimize the risk that others will encounter the waste or that it will reach water supplies. These risks can be most effectively minimized by walking far from campsites, trails, and water bodies to seek a disposal site. Adequate burial adds further protection from risk of pollution or encountering waste. Contrary to popular belief, burial is not a means of increasing decomposition; it is primarily a means of slowing dispersal toward water and separating waste from other humans. The importance of widespread dispersal of waste disposal sites is suggested by recent research that reported survival of pathogenic indicators for a year or more (Temple and others 1982).
IMPORTANCE	Moderate to high. Importance varies with amount of use. This practice is of critical importance in regularly visited places. In remote, little-visited places, however, disposal practices can be more lax. In unused places, surface disposal is acceptable; this will increase decomposition rates and avoid the disturbance associated with excavating a hole. (Surface disposal should probably not be generally recommended.) Given the significance attached to problems of esthetics and human health, this practice is among the most important in regularly visited places. It becomes both increasingly important and increasingly difficult as use intensities increase.
CONTROVERSIAL ELEMENTS	Attempts to establish quantitative standards have resulted in inconsistent recommendations. Recommended appropriate distance from campsites, trails, and water range from 100 to 300 feet. Recommended depths for disposal range from 4 to 10 inches. These differences are not critical, although it would be best for distance from campsites to suggest that visitors go as far as possible. Other recommendations include use of group latrines and deposition on the surface. These practices are not generally recommended, although there are special situations where they might be appropriate.
KNOWLEDGE NEEDS	Rapid decomposition of waste reduces risk of contamination. We need to know more about environmental factors that promote rapid decomposition of feces. This would improve our ability to provide more specific recommendations about good disposal sites.
FREQUENCY OF RECOMMENDATION	Very common.
COSTS TO VISITORS	Moderate. This practice requires some time and care to walk far enough from camp and to excavate an adequate hole.
SPECIAL SITUATIONS	Certain environments offer unique opportunities for human waste disposal. Crevasses on glaciers can make good disposal sites. Otherwise, proper waste disposal on snow and ice is difficult. Selecting a site far from places that are used during any season becomes critical. Waste disposal below high tide offers an opportunity on low-use beaches. On rivers, equipment is available that permits all waste to be carried out in portable toilets (Hampton and Cole 1988). This is an extremely effective means of minimizing problems. Waste deposition on the surface may be appropriate in very lightly used areas where excavation of holes can cause long-term impact. Spreading the feces on a dry and exposed site will maximize exposure to sunlight and, therefore, decomposition. Finally, latrines may be necessary for long stays by large groups in popular areas. This situation should be avoided, however, because decomposition rates are extremely slow in latrines, and excavation by animals is a serious problem.

PRACTICE 56- USE BIODEGRADABLE SOAP IN SMALL AMOUNTS, IF AT ALL

DESCRIPTION	Minimize use of soap. Use small quantities of a biodegradable soap and keep soap out of water bodies (practice 57).
SAMPLE MESSAGES	<p>"Minimize your use of soaps since even biodegradable soaps are pollutants. (86)</p> <p>"The use of soaps or detergents containing phosphates must be avoided to prevent contamination of backcountry water sources and vegetation damage." (9)</p>
PROBLEMS ADDRESSED AND RATIONALE	(1) Water pollution. Pollution of water is avoided by keeping all soap, even biodegradable soap, out of water bodies. (2) General disturbance of natural conditions. Disturbance, most often on and around campsites, is minimized by using biodegradable soap in small quantities. Soap with phosphates adds nutrients to soils, which can lead to alteration of vegetation.
IMPORTANCE	Low to moderate. The significance of problems created by soap pollutants is poorly understood. As long as soaps are kept out of water bodies (practice 57), problems may not be substantial.
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	Although it would not change the recommendation, a better understanding of the nature and significance of soap pollution would permit an evaluation of importance.
FREQUENCY OF RECOMMENDATION	Common.
COSTS TO VISITORS	Minimal.

PRACTICE 57- BATHE, WASH, AND DISPOSE OF WASTE WATER AWAY FROM WATER BODIES AND CAMPSITES

DESCRIPTION	Bathing in water bodies is acceptable if soap is not used. If soap is used, get wet; carry water in a pot to a place away from the water and campsites; soap and lather up; and rinse off. Dishes should also be washed away from water bodies and campsites so that soap, food scraps, and waste water do not pollute them.
SAMPLE MESSAGE	"All soap pollutes lakes and streams. If you bathe with soap, jump into the water first, then lather at least 100 feet from the water, and rinse the soap off with water carried in jugs or pots. This allows the biodegradable soap to break down and filter through soil before reaching any body of water. Clothes can be adequately cleaned by thoroughly rinsing. Soap is not necessary. Dishes should be washed away from water sources. Dishwashing is simple; don't use soap. If food sticks, fill the pan with cold water and let it soak several hours or overnight (except in grizzly bear country). Clean jars or narrow-mouthed containers by shaking pebbles and water inside them. Scrub the insides of pots with sand, gravel, pine cones, or a pine needle cluster." (6)
PROBLEMS ADDRESSED AND RATIONALE	(1) Water pollution. Soap and food scraps can pollute water bodies by contributing nutrients that had limited aquatic growth. Water clarity can be adversely affected and the food chain can be altered. (2) Deterioration of established campsites. In camp, food scraps can draw flies and be esthetically unattractive.
IMPORTANCE	Unknown, probably moderate. The susceptibility of water bodies to pollution and the significance of potential problems is poorly understood. Lakes in a heavily used lake basin in the Sierra Nevada have unusual chemistry and biota believed to reflect a history of heavy use and water pollution (Taylor and Erman 1979, 1980). Problems may be confined to water bodies with high susceptibility in places that are heavily used. This practice can alleviate problems even under these circumstances.
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	Although it would not change the recommendation, a better understanding of the nature and significance of water pollution would permit a better evaluation of importance.
FREQUENCY OF RECOMMENDATION	Very common.
COSTS TO VISITORS	Moderate. This practice requires more time and energy than washing and bathing directly in water.
SPECIAL SITUATIONS	In grizzly bear country it is important to wash dishes immediately after use, in an area far from sleeping places. Where risk is very high, washing directly in water may be justified as a means of minimizing odors.

Additional Practices for Parties With Stock

PRACTICE 58- USE PROPERLY TRAINED STOCK

DESCRIPTION	Stock should be in good condition for mountain travel. Stock should be trained to methods of containment that will be used, as well as equipment. Stock should be fed weed-free food for several days before entry.
SAMPLE MESSAGE	"Animals conditioned to strenuous mountain travel are at home on the trail and accustomed to supplemental feeds and various methods of containment. Horses that react to strange looking ropes or corrals can cause damage or injure themselves. Introducing stock to hobbles, picket pins, hitch lines, and various temporary corrals in a familiar environment may avert a major calamity at some remote camp.' (19)
PROBLEMS ADDRESSED AND RATIONALE	(1) Deterioration of established trails, (2) deterioration of established campsites, (3) proliferation of campsites, and (4) deterioration of grazing areas. Properly trained stock can be managed more easily; therefore, it is more likely that such stock will be handled properly. Properly trained stock are more likely to stay on trails and to cause less damage around campsites and in grazing areas. They are less likely to need to be confined, a practice that commonly results in severe alteration.
IMPORTANCE	Moderate. This practice makes it easier to apply other low-impact stock practices.
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Rare.
COSTS TO VISITORS	Low to moderate. Although this practice requires advanced planning and preparation, it will contribute greatly to a more enjoyable trip.

PRACTICE 59- CARRY APPROPRIATE EQUIPMENT

DESCRIPTION	Horses should be shod with flat plates or not at all. Other items to bring include supplemental feed, nosebags (for feed), hobbles, a hitch line with "tree-saver straps" (USDA FS 1981), and bug repellent and fringed eye guards to reduce aggravation caused by flies and mosquitoes. Carry an ax to chop out downed logs, but avoid using it to gather firewood (practice 44). Follow the recommendations on equipment for all wilderness users (practice 2). Otherwise, take as little equipment and as lightweight equipment as possible to minimize the number of stock.
SAMPLE MESSAGE	"Take only as much gear as you need for the trip. Use lightweight gear. Use picket lines or hobbles. Pack in processed grains and hay pellets where grass is scarce." (12)
PROBLEMS ADDRESSED AND RATIONALE	(1) Deterioration of established trails, (2) development of unwanted trails, (3) deterioration of established campsites, (4) proliferation of campsites, and (5) deterioration of grazing areas. Proper and lightweight equipment will minimize the inevitable 'wear-and-tea?' caused by packstock. Use of supplemental feed will reduce grazing impacts. Equipment designed to minimize the impact caused by confined stock is particularly important.
IMPORTANCE	Moderate to high. In places with substantial packstock use, stock impacts are severe except where special care is taken to limit those impacts. These suggestions make it easier to be gentle to the land.
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Uncommon.
COSTS TO VISITORS	Moderate to high. Many stock users have become accustomed to a style of wilderness use that includes large quantities of heavy equipment. This tradition needs to change and be replaced by use of lightweight equipment more similar to that used by the backpacker.

PRACTICE 60- MINIMIZE THE NUMBER OF STOCK

DESCRIPTION	Take as few head of stock as possible. Minimizing the amount and weight of equipment is critical to minimizing the number of stock.
SAMPLE MESSAGES	"Take the minimum number of stock to make your trip successful.' (9)
PROBLEMS ADDRESSED AND RATIONALE	(1) Deterioration of established trails and (2) deterioration of established campsites. Reducing the number of stock can reduce damage to existing trails and campsites in some places. (3) Development of unwanted trails and (4) proliferation of campsites. Of more importance, large parties are more likely to create new trails and campsites if they travel off trail or use previously undisturbed campsites. (5) Deterioration of grazing areas and (6) competition with wildlife. Grazing areas will deteriorate more rapidly and severely when large numbers of stock graze. In places, this can result in competition with wildlife. (7) Visitor conflict. Visitor conflicts between stock and backpacker parties are also more serious where stock parties are large.
IMPORTANCE	High. The size of stock parties influences the severity of a number of problems. Particularly in little-used and off-trail places, it is critical that stock party size is minimized.
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Rare.
COSTS TO VISITORS	Moderate to high. This can require a substantial change in style of use. Many traditional comfort and convenience items would have to be left behind. Most of these can be replaced by lightweight equipment used by backpackers.

PRACTICE 61- STOCK SHOULD STAY ON ESTABLISHED TRAILS AS MUCH AS POSSIBLE

DESCRIPTION	Parties with stock should travel as much as possible on designated trails, rather than taking off-trail routes. When on trails, stock should be tied together (practice 63) and led single file along the main tread. They should not be allowed to spread out or to walk on parallel or developing trails.
SAMPLE MESSAGE	'Stay on designated trails.' (33) "Keep your stock on the trail tread." (12)
PROBLEMS ADDRESSED AND RATIONALE	(1) Deterioration of constructed trails and (2) development of undesired user-created trails. Trampling impacts of packstock are particularly severe because considerable weight is carried on a small bearing surface (Weaver and others 1979). Therefore, vegetation and soil damage occur rapidly where stock leave the trail. This is why it is best for stock to stay on constructed trails as much as possible. Where stock leave the main trail tread, trail widening and development of parallel trails are likely. Where stock travel off trail, new trails can be created rapidly.
IMPORTANCE	Moderate. This practice can be effective in minimizing trail deterioration problems caused by packstock use; however, severe trail problems are usually more a result of poor trail location and design than of type of use.
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Rare.
COSTS TO VISITORS	Moderate. Costs are minimal to most users—those who prefer trail travel. Those who enjoy off-trail travel will bear more cost, however. Off-trail travel with stock is acceptable if special care is taken (practice 6).
SPECIAL SITUATIONS	With careful planning, off-trail travel with stock is acceptable. The number of stock must be small, and parties should be prepared to practice low-impact techniques. Routes should be carefully selected for their durability.

PRACTICE 62- REMOVE TRAIL OBSTACLES INSTEAD OF SKIRTING THEM

DESCRIPTION	When encountering a trail obstacle, such as a fallen log, stock parties should remove it and make the main trail passable again. Do not leave the trail to skirt the obstacle. Notify the managing agency if the obstacle cannot be removed.
SAMPLE MESSAGE	“Trail obstacles are part of any wilderness journey. When possible riders clear trails to make travel easier for themselves and others. When a detour is necessary, local managers are notified so the trail can be cleared before an alternate route forms.” (19)
PROBLEM ADDRESSED AND RATIONALE	Deterioration of constructed trails. Where stock leave the trail to skirt an obstacle, the trail will widen or an alternate tread will develop. This deterioration can only be avoided by removing the obstacle and keeping stock on the main tread.
IMPORTANCE	Moderate. This is an effective way to eliminate one cause of trail deterioration. It is not one of the more critical trail problems, however.
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Rare.
COSTS TO VISITORS	Moderate. Clearing obstacles requires time and effort on the part of stock parties, although in few situations will obstacles be frequent enough to require a prohibitive effort.

PRACTICE 63- LEAD STOCK ON THE TRAIL, RATHER THAN LOOSE-HERD THEM

DESCRIPTION	Stock should be tied together and led down the trail. They should not be turned loose and herded down the trail.
SAMPLE MESSAGE	"On the trail pack stock should be led rather [than] loose-herded." (9)
PROBLEMS ADDRESSED AND RATIONALE	(1) Deterioration of constructed trails. Loose stock will leave the constructed trail, widening it, creating parallel trails, and shortcutting switchbacks. Leading them on short strings will minimize these problems, as well as the risk of losing a load (2) Visitor conflict. Leading stock will also cause less conflict with parties met on the trail.
IMPORTANCE	Low to moderate. Stock leaving the trail tread are a major cause of trail deterioration. This practice will reduce this source of trail problems.
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Uncommon.
COSTS TO VISITORS	Low. Leading stock is easier than herding them.

PRACTICE 64- TIE STOCK OFF TRAIL, ON A DURABLE SITE, WHEN TAKING A BREAK

DESCRIPTION	When it is time to take a break, move off the trail far enough so that other parties can pass unnoticed. Select a durable site for the break, tying stock in a place and manner that will not cause impact. Avoid tying stock to trees (practice 74).
SAMPLE MESSAGE	"At rest stops-even short ones-stock are tied well off the trail. It's courteous and minimizes trail wear. If it's a scenic overlook, historic site, or other popular stop, stock are kept out of the area." (19)
PROBLEMS ADDRESSED AND RATIONALE	(1) Deterioration of constructed trails. Taking a rest stop adjacent to the trail is likely to cause trail widening and deterioration at that spot. This can be avoided by moving off trail to a durable spot. (2) Too many encounters and (3) visitor conflict. Moving off trail will also reduce the number of trail encounters and conflicts between stock and hiker parties.
IMPORTANCE	Low to moderate. Although this practice reduces problems, contrary behavior is not one of the more serious sources of problems.
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Rare.
COSTS TO VISITORS	Low. This practice requires more time and care, but experiences are enhanced by getting away from the trail for breaks.

PRACTICE 65- AVOID PLACES THAT HAVE ALREADY BEEN HEAVILY GRAZED

DESCRIPTION	Places that have already been heavily grazed should not be grazed further. They can be used as camping area ⁵ if enough processed feed is available to avoid grazing. Otherwise, move to a camping area that has adequate forage.
SAMPLE MESSAGE	<p>No straightforward statement of this recommendation was found. The following contains some of the idea:</p> <p>“Be certain meadows in the area will support the grazing needs of the livestock. Both water and grass supplies should be carefully examined. Frequently used area⁵ are often exposed to heavy grazing through the season. Overgrazing contributes to a reduction in the active strength of the grasses, adds to the trodden-out appearance of the meadows, provides opportunities for unwanted weeds to grow and generally adds to the degradation of the area. The amount of feed available or the amount of feed packed in will determine the length of your stay.” (9)</p> <p>In some areas, overgrazed meadows have been closed to grazing.</p>
PROBLEM ADDRESSED AND RATIONALE	Deterioration of grazing areas Further grazing of meadows that have already been heavily grazed is likely to cause long-term deterioration. This practice should avoid that.
IMPORTANCE	High. This practice is critical to avoiding the degradation of grazing areas.
CONTROVERSIAL ELEMENTS	The concept is not controversial; however, there is probably little agreement on how much grazing meadows can sustain before further grazing should be avoided.
KNOWLEDGE NEEDS	We need more information on the effect ⁵ of various levels of grazing on the condition of grazing areas. This would provide a more informed perspective on the point at which further grazing becomes extremely detrimental.
FREQUENCY OF RECOMMENDATION	Rare.
COSTS TO VISITORS	Moderate. Visitors may be unable to graze stock in preferred locations. This follows from the fact that those places that are most overgrazed are often those that are most preferred. The option to bring in feed (and still camp in the area) reduces costs.

PRACTICE 66- KEEP STOCK OFF CAMPSITES AS MUCH AS POSSIBLE

DESCRIPTION	Never confine or allow stock to roam on the campsite. They should be kept some distance away-where they will not foul the site. If necessary, bring them onto the campsite to be quickly loaded or unloaded. If they relieve themselves during this period, be careful to remove the manure.
SAMPLE MESSAGE	"Stock are never kept in camp. They are tied some distance away." (19)
PROBLEMS ADDRESSED AND RATIONALE	(1) Deterioration of established campsites and (2) visitor conflict. Stock can cause severe trampling damage if allowed on campsites (Cole 1983:13). They also leave manure, which greatly reduces the desirability of the campsite to many visitors. These sources of impact are unnecessary if stock are kept away from the site.
IMPORTANCE	High. Stock cause severe ecological and esthetic impact to campsites. This practice effectively limits this problem.
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Uncommon.
COSTS TO VISITORS	Low. This practice requires some planning and coordination to load and unload stock quickly and move them off site. Behavior is not greatly constrained, however.

PRACTICE 67- KEEP LENGTHS OF STAY AT ONE PLACE SHORT

DESCRIPTION	Move to another campsite before forage is overgrazed and before places where stock are confined show excessive trampling damage. In fragile areas and during particularly vulnerable times of the year this may mean moving every day. In places with abundant forage and durable sites for confining stock, long stays are acceptable. Check with the managing agency about forage conditions.
SAMPLE MESSAGE	<p>No examples of this precise recommendation were found, although some of the idea is captured in the following:</p> <p>"Avoid prolonged stock grazing in one area; it can have a serious impact on vegetation." (82)</p>
PROBLEMS ADDRESSED AND RATIONALE	(1) Deterioration of established campsites, (2) proliferation of campsites, (3) deterioration of grazing areas, and (4) competition with wildlife. Grazing areas can sustain only a certain amount of grazing before long-term deterioration occurs (Strand 1979). Stock parties must move to another camp before this stage is reached. If the area is used frequently by other parties, or productivity is low, stays must be short to avoid deterioration and, in some places, competition with wildlife. Given the severe stresses caused by the trampling of stock, campsites can deteriorate rapidly unless stock are confined to highly durable sites. Particularly on previously unused or lightly used campsites, stays must be very short or highly impacted campsites will be created. Although less of a problem, long stays at established campsites can also cause excessive deterioration.
IMPORTANCE	High. Deterioration of grazing areas is one of the most widespread impacts in many wildernesses (Washburne and Cole 1983); stock impacts also are a major source of both excessive deterioration of campsites and the rapid proliferation of campsites. Although length of stay is probably less important than appropriate confinement of stock (see practices 71, 73, and 74 in particular), it is an important influence on amount of impact.
CONTROVERSIAL ELEMENTS	The general concept as stated here is not controversial. Any attempt to set quantitative limits on lengths of stay would be controversial because appropriate lengths of stay vary so greatly with such factors as previous impact, season, environmental conditions, and horse-handling practices.
KNOWLEDGE NEEDS	A better understanding of how much grazing different meadow types can sustain would help ascertain appropriate lengths of stay.
FREQUENCY OF RECOMMENDATION	Rare.
COSTS TO VISITORS	Moderate. This practice may require more frequent movement of camps than desired. This cost can be reduced by carefully planning to visit places that can support the lengths of stay desired. Also, by carrying supplemental feed and taking the time and care to confine stock properly, lengths of stay can be extended.

PRACTICE 68- WATER STOCK DOWNSTREAM FROM DRINKING SOURCES ON A DURABLE SPOT

DESCRIPTION	Pick a spot downstream from your camp and others in the vicinity to water your stock. Pick a spot that can handle the trampling, preferably a place with low banks that are hard and rocky or gravelly. Take stock to this place shortly after arriving in camp. Watering stock with a bucket can also reduce streambank impacts.
SAMPLE MESSAGES	<p>Horses should be watered downstream from the source of your drinking water and well away from the campsite area. When watering horses, avoid fragile streambanks and lake shore areas." (9)</p> <p>'Stock are led to water at a rocky spot where little bank damage will occur. Soft or marshy lake edges are avoided." (19)</p>
PROBLEMS ADDRESSED AND RATIONALE	(1) Deterioration of grazing areas. The banks of water bodies are often steep and moist. These characteristics make these sites particularly prone to disturbance. Damage to stream and lake banks can be minimized by watering stock in places where banks are not steep and where soils are dry and hard (2) Water pollution. Recreational packstock are a source of bacterial contamination of drinking water. Therefore, it is important to keep them out of waters to be used for drinking.
IMPORTANCE	Moderate. This practice can be effective in minimizing health hazards created by packstock and with the breakdown of banks. These are not among the most serious and prevalent wilderness problems, however.
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Rare.
COSTS To VISITORS	Low. It may take additional time to show stock a durable place to water. But a major time commitment or shift in behavior is not required.

**PRACTICE 69- CARRY AN APPROPRIATE AMOUNT OF WEED-FREE
SUPPLEMENTAL FEED**

DESCRIPTION	Bring some feed along so some of the grazing impact is reduced. This is particularly important when visiting either popular places or places where forage is limited. Feed should be weed free; processed feed avoids this problem. It is important to condition stock, before the trip, to eating small quantities of processed feed.
SAMPLE MESSAGES	<p>“Plan on carrying supplemental feed for your stock. In many backcountry areas forage is limited and grazing may be restricted or unavailable. Inquire at the local Ranger Station about the conditions so that you will know how much supplemental feed to carry.” (12)</p> <p>Weed-free oats or pelletized feeds are preferable to hay, which is more bulky to pack. If hay is used it should be certified weed-free.” (9)</p>
PROBLEMS ADDRESSED AND RATIONALE	(1) Deterioration of grazing areas and (2) competition with wildlife. Overgrazing causes grazing areas to deteriorate and can remove forage needed by wildlife. Supplemental feed can reduce the dependency on forage, thereby reducing the likelihood of meadow deterioration and competition with wildlife. Exotic plants and weeds are a common problem in grazing areas. Weeds can spread into wilderness in feed for stock. To avoid this problem, feed should be either weed free or processed.
IMPORTANCE	Low to high. It is always important to keep weeds out of feed; however, weeds will also enter the wilderness on the body and hooves of stock. So use of weed-free feed will be only a partial solution to the problem. The use of supplemental feed is not important where forage is abundant and use levels are low. It is extremely important where forage is sparse and/or where use levels are high.
CONTROVERSIAL ELEMENTS	Packing in supplemental feed can make it necessary to bring in more animals. Thus, there is a tradeoff between the increased damage caused by more animals and the reduced damage resulting from less reliance on forage. As trips increase in length, the advantages of bringing in feed decline.
KNOWLEDGE NEEDS	A better understanding of the relationship between amount of grazing and deterioration would contribute to more useful guidelines about where supplemental feed is needed and a better perspective on the importance of supplemental feed.
FREQUENCY OF RECOMMENDATION	Uncommon.
COSTS TO VISITORS	Moderate to high. This can require the added cost of supplemental feed and the need to take more animals into the wilderness. Use of supplemental feeds can remove some of the hassles associated with proper grazing practices and finding campsites with sufficient forage.
SPECIAL SITUATIONS	A number of wilderness areas require all feed to be packed in. A number also prohibit the use of hay or unprocessed feed.

PRACTICE 70- PLACE FEED AND SALT ON A TARP OR IN A FEEDBAG OR CONTAINER

DESCRIPTION	Place salt blocks on a tarp, a notched log, or some other container. Keep salt off the ground. By using processed feed, with salt added, there is no need for supplemental salt. Supplemental feed should be placed in a nosebag or on a tarp. Do not place directly on the ground.
SAMPLE MESSAGES	<p>When feeding hay or grains that have been packed in, lay the hay out on a pack tarp or sheet of plastic.” (9)</p> <p>‘Supplemental feeds in cubes and pellets can be fed . . . in nose bags. [Salt blocks] are set out in a notched log or other container. This prevents rain from leaching salt into the soil, destroying vegetation, and attracting wildlife that paw up the ground.” (19)</p>
PROBLEMS ADDRESSED AND RATIONALE	Deterioration of grazing areas. If feed or salt is placed directly on the ground, stock or wildlife are likely to paw up and unnecessarily disturb the ground.
IMPORTANCE	Low. This is not one of the more significant causes of impact to grazing and camping areas.
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Rare.
COSTS TO VISITORS	Low. Nosebags and tarps are all that is needed

PRACTICE 71- MINIMIZE CONFINEMENT OF STOCK WHEN GRAZING; MOVE PICKETED STOCK FREQUENTLY

DESCRIPTION	Let stock graze freely, using hobbles if they need to be restrained. Avoid confining stock while they graze. If they must be picketed, move picket pins frequently-every few hours. Use metal pins rather than pins made from wood found on the site.
SAMPLE MESSAGES	<p>“Restrained animals can do considerable damage by pawing and trampling the vegetation. Hobbles are the best device for restraining stock. The animal can move enough to graze but is not confined as in picketing.” (9)</p> <p>“Once in camp, travelers allow their stock to graze. Because picketing can cause considerable plant and soil damage, most stock is hobbled. Visitors picket only enough horses to keep the others from straying. Since they know it is illegal and environmentally improper to cut green trees, visitors carry metal picket pins for moving the horses easily two or three times a day.” (35)</p>
PROBLEM ADDRESSED AND RATIONALE	Deterioration of grazing areas. In addition to overgrazing of entire grazing areas, confinement of stock on part of a grazing area can cause substantial local deterioration. For this reason it is important to either allow horses to graze freely or, if they are picketed, to rotate stock frequently. This disperses grazing pressure and impact across a larger grazing area. Even with dispersal and rotation of grazing pressure, it is important not to overgraze the entire area by staying too long (practice 66).
IMPORTANCE	High. Careless confinement of stock is a primary source of impact in many places. Considerable damage can occur in relatively short periods of time. That is why confinement should be avoided as much as possible. When it cannot be avoided, it becomes necessary to invest considerable effort in frequently moving stock. Otherwise, serious deterioration will occur.
CONTROVERSIAL ELEMENTS	Some wilderness managers are more favorable toward picketing than others. This probably reflects their tradition of use. Meadow deterioration is likely to occur wherever stock is picketed, unless great care is exerted. Temporary corrals have also been suggested as a means of confining animals, particularly for long periods of time. This is likely to result in overgrazing of the corral area and, therefore, is not generally recommended.
KNOWLEDGE NEEDS	A better understanding of the effects of restraining stock in various ways for different periods of time would provide a better perspective on the importance of this recommendation. It would also provide more definitive guidelines on proper rotation frequency if using pickets.
FREQUENCY OF RECOMMENDATION	Rare (for minimizing confinement) to uncommon (for the need to frequently rotate picket pins).
COSTS TO VISITORS	Moderate to high. Costs are not substantial for well-trained stock and experienced stock handlers. Stock that are not well trained may run away if allowed to graze freely, and they may not handle hobbles well. If stock must be picketed, considerable time and effort must be invested in rotating animals before damage occurs.

PRACTICE 72- USE EXISTING HITCH RAILS AND CORRALS WHERE AVAILABLE

DESCRIPTION	In places where managing agencies have provided hitch rails or corrals for tying up stock, use these facilities.
SAMPLE MESSAGE	"Use existing camping and horse facilities when provided." (11)
PROBLEMS ADDRESSED AND RATIONALE	(1) Deterioration of established campsites and (2) proliferation of campsites. Hitch rails and corrals concentrate the impact caused by the confinement of stock. Stock is concentrated not only on certain campsites but also on one spot on these campsites. Where such facilities are provided but not used, stock impacts spread to other places. This can result in both the proliferation of sites damaged by stock and excessive deterioration of individual sites.
IMPORTANCE	High. Although horse-holding facilities are uncommon in wilderness, it is important that they be used when provided by the managing agency. At camping areas that are popular with stock parties, this is an effective way of limiting stock damage to a small area. Not using facilities defeats this strategy and results in unnecessary disturbance.
CONTROVERSIAL ELEMENTS	Most wilderness visitors are opposed to the provision of stock facilities in wilderness (Stankey and Schreyer 1987). This may reflect an assumption that they are being provided for convenience rather than resource protection and therefore are not appropriate. What we know about the nature of packstock impact suggests that, in popular places, concentrating stock is the most effective means of limiting inevitable disturbance (Cole 1983b). While many object to this strategy of concentrating impact in "sacrifice areas," the concept of using facilities where they are provided is not controversial.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Rare.
COSTS TO VISITORS	Low. Most stock parties appreciate the convenience of using agency-built facilities.

PRACTICE 73- WHERE CONFINEMENT IS NECESSARY, USE A HITCH LINE ON A DURABLE SITE AWAY FROM WATER

DESCRIPTION	Stock should be allowed to run free (or with hobbles) as much as possible. If they must be tied up and confined, use a hitch line between two large trees. Use 'wide "tree-saver straps" (USDA FS 1981) to encircle the trees. Tie more than one horse to the line; this will tend to minimize idle pawing of the ground. Hobbling animals will also reduce pawing. Locate the hitch rail on a durable, hard site, preferably rocky or gravelly and without vegetation. It should be away from campsites (see practice 65) and from water. Never tie horses to trees for an extended period of time (see practice 74). Hitch rails and corrals are not necessary; they cause more disturbance than a hitch line.
SAMPLE MESSAGES	<p>'Remember, any time stock is restrained, particularly if they are away from home and their special partners, they can cause considerable damage to trees, plants, and soil by pawing and tramping. If it is necessary to keep stock tied for any length of time, the following should be considered: (a) Use a rope hitch rail at least 200 feet from any water, trail, or campsite. (b) Select a site where they cannot tramp on tree roots and where damage to plants will be minimized. Rocky, hard ground is usually best. (c) If an animal is inclined to paw while tied, it can do considerable damage to the soil and plants. This type should be hobbled while tied. (d) If some horses are kept tied, while others are turned loose to graze at night or in the day-time, it is almost always best to keep two horses tied rather than one. Two will usually stand quieter.'" (18)</p> <p>'A hitch line is a good idea. Stock can be quickly tied, kept in order, and easily watched. Wide nylon 'tree-saver straps' with quick-adjusting buckles are used for speed and convenience. Rope is run between the straps, tied with a quick-release knot, and pulled taut.'" (19)</p>
PROBLEMS ADDRESSED AND RATIONALE	(1) Deterioration of established campsites, (2) proliferation of campsites, and (3) water pollution. Confined stock can cause considerable damage to vegetation, soil, trees (if they are tied to trees), and water. The best alternative is to avoid confining stock. If they must be tied, it is important to select a location where disturbance will be minimized. Sites without vegetation and with a hard, rocky surface that cannot be churned up are best. It is also important to avoid disturbing campsites and to avoid contaminating water bodies. A hitch line is best because no native materials are used (as hitch rails and pole corral5 do) and it minimizes the area disturbed; with corrals, a much larger area is disturbed.
IMPORTANCE	High. Disturbance caused by confined stock is a major source of impact on and around backcountry campsites. A few stock parties can cause substantial disturbance. Concentrating that impact on durable sites is the most effective means of limiting the problem.
CONTROVERSIAL ELEMENTS	Hitch rails, corrals, and trees are also used to confine stock. All of these practices cause more damage and are unnecessary.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Uncommon.
COSTS TO VISITORS	Low. Attempts to avoid confinement entirely require more training of stock and higher risk of having stock stray. Using a hitch line in a proper location-as opposed to tying stock to trees or building a hitch rail or corral-is not much more difficult or time consuming.

PRACTICE 74- AVOID TYING STOCK TO TREES, PARTICULARLY SMALL TREES

DESCRIPTION	For breaks that last only a few minutes, it is acceptable to tie stock directly to trees-if they are larger than about 8 inches in diameter. Never tie stock to smaller trees and never tie stock to any tree for a long time. Use a hitch line between two trees instead (see practice 73).
SAMPLE MESSAGES	<p>"To prevent tree damage, tie your stock to trees for only short rest periods." (33)</p> <p>"When tying stock to trees the tree must be large enough to avoid rope damage to the bark. The diameter of the tie rope must also be large enough to avoid bark damage. Padding between the rope and the tree is recommended." (9)</p>
PROBLEMS ADDRESSED AND RATIONALE:	(1) Deterioration of established campsites, (2) proliferation of campsites, and (3) general disturbance of natural conditions. Stock tied to trees can girdle and kill the tree, particularly if it is a small tree. When stock are tied to trees for long periods, they excavate wells around the base of trees, exposing and trampling roots. This practice seeks to avoid this unnecessary disturbance by suggesting alternative less-damaging practices (see practice 73).
IMPORTANCE	High. Tree damage and root exposure resulting from stock tied to trees is a pervasive problem on campsites. Using a hitch line instead is a simple way to avoid this problem.
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Uncommon.
COSTS To VISITORS	Low. The hitch line with tree-saver straps is a simple alternative to tying stock directly to trees.

PRACTICE 76- RENOVATE PAWED-UP AREAS; SCATTER MANURE; REMOVE PICKET PINS AND EXCESS FEED AND SALT

DESCRIPTION	In addition to normal camp cleanup, several of the disturbances unique to stock parties must be dealt with. Wherever stock have been, it is important to scatter manure and smooth over any pawed-up areas. If picket pins were used, they should be removed. If salt and feed are left over, they should be packed out.
SAMPLE MESSAGE	"And when it's time to break camp nothing is left behind. Temporary hitch rails and corrals are dismantled, and manure piles are scattered to aid decomposition, discourage flies, and as a courtesy to others." (19)
PROBLEMS ADDRESSED AND RATIONALE	(1) Deterioration of established campsites and (2) proliferation of campsites. This practice is intended to make established campsites attractive to subsequent users and to remove all evidence of your stay on previously unused sites. (3) Deterioration of grazing areas. Leaving picket pins encourages the next party to picket their stock in the same place; this quickly leads to overgrazing.
IMPORTANCE	Moderate. This practice can reduce the impacts associated with stock use; however, it is less critical than the practices associated with proper confinement and restraint of stock (practices 71, 73, and 74).
CONTROVERSIAL ELEMENTS	None.
KNOWLEDGE NEEDS	None.
FREQUENCY OF RECOMMENDATION	Uncommon.
COSTS TO VISITORS	Moderate. This requires some time and energy on the part of stock parties. That requirement is small compared with the time generally required for handling stock and can be considered a responsibility that must be accepted for the privilege of taking stock into the backcountry.

PRACTICES THAT CAN BE COUNTERPRODUCTIVE

The following four commonly recommended practices should not be generally recommended. They are likely to have more negative consequences than positive benefits.

1. VISIT WILDERNESS DURING LESS POPULAR DAYS OF THE WEEK AND/OR SEASONS

DESCRIPTION	Most people visit the wilderness on weekends and, in most places, during summer. Spring, winter, and fall can be particularly popular seasons in the South. Plan trips so that they fall during weekdays and less popular seasons of the year.
PROBLEM ADDRESSED AND RATIONALE	Too many encounters. Solitude tends to decline as the number of encounters between parties increases. The number of encounters is also strongly influenced by the number of parties in the wilderness at one time. Because this number is highly concentrated during certain seasons and days of the week (Roggenbuck and Lucas 1987), the number of encounters at more popular times could be reduced by encouraging more parties to shift their visits to less popular times. This would constitute shifting use from weekends to weekdays and from popular to unpopular seasons (in mountainous areas, for example, from midsummer to other seasons).
NEGATIVE CONSEQUENCES	Shifting use to seasons other than summer may involve shifting it to seasons when trails, meadows, and animals are more vulnerable to damage. Thus, this practice may conflict with practices 4 (avoid trips where and when soils are wet and muddy) and 5 (avoid trips where and when animals are particularly vulnerable to disturbance). Shifting use to weekdays and less popular seasons also can have the negative consequence of increasing encounter levels at these times. It is not clear how to evaluate the overall costs and benefits of simultaneously decreasing encounter levels at popular times and increasing encounter levels at other times. Visitors that seek out low-use times and expect to see few people are particularly vulnerable to the increase in encounters that is likely to accompany temporal shifts in use.
FREQUENCY OF RECOMMENDATION	Uncommon.
CONCLUSION	General recommendations to visit during less popular times of the year appear to have more potential costs than benefits. Information about use levels at various times might be given to visitors to help them make better-informed decisions-but not to attempt to influence their decisions. Even when providing information, it is important to suggest caution about use when the environment is fragile (such as during early season snowmelt) or when animals are vulnerable to disturbance (such as during winter).

2. AVOID VISITING MORE POPULAR PLACES IN THE WILDERNESS

DESCRIPTION	When planning a trip, select trailheads, trails, and destination areas that are not heavily used. Avoid places that are popular and likely to be crowded."
PROBLEMS ADDRESSED AND RATIONALE	(1) Too many encounters. Shifting use away from popular places should reduce the number of encounters in these places. If the shift is pronounced enough, opportunities for solitude should improve in popular places. (2) Deterioration of grazing areas. Reduced grazing of popular forage areas would reduce the prevalence and severity of overgrazing. (3) Human waste. Reduced use of popular places without toilets could reduce problems with accumulation of human waste. A number of other problems, such as trail and campsite deterioration and wildlife impacts, might be reduced in popular places by this practice; however, the practice would be relatively ineffective because there is only a weak relationship between these problems and amount of use.
NEGATIVE CONSEQUENCES	Visitor use that is shifted away from popular trails and destination areas will go elsewhere. This can result in the creation of problems in places that did not have problems before. Virtually all types of problem- trail and campsite deterioration and proliferation, litter, increased encounter levels, and wildlife impact problems-are likely to increase. Negative consequences in currently little-used places are likely to outweigh positive benefits in popular places. Both loss of solitude and increase in ecological impact are greater where use levels increase from low to moderate than where they increase a similar amount, but from moderate to high levels (Cole 1987b; Stankey 1973). This suggests that the increase in problems created by increased use of little-used places is likely to be much greater than the reduction of problems caused by decreased use of popular places. In addition, the number of places where new problems are likely to develop is likely to be greater than the number of places at which problems will be reduced. Moreover, the currently little-used places are the ones that come closest to meeting the ideals laid out in the Wilderness Act; their integrity should not be sacrificed in order to reduce problems elsewhere.
FREQUENCY OF RECOMMENDATION	Uncommon.
CONCLUSION	In most situations, general recommendations about visiting less popular places are likely to be counterproductive. It is not clear that this practice will alleviate problems substantially in popular places; there are more effective ways to deal with most problems (such as requiring supplemental feed for stock, providing toilets, and selecting 'out-of-the-way" campsites). Moreover, it is likely that problems will be created in currently little-disturbed places. There are situations, however, where it is appropriate to divert use from specific overused places to identified alternative use locations (Roggenbuck and Berrier 1981; Thornburgh 1986). This could be particularly useful in avoiding wildlife impacts-by advising people to stay away from or to not camp in certain critical habitats or places (such as in meadows in general or at a specific critical meadow).

3. BUILD FIRE IN A HOLE CUT IN SOD

DESCRIPTION

Build a campfire in dense vegetation by digging a pit, through the sod, down to mineral soil. Remove the plants in as large a block as possible and place them and the soil some distance from the pit. Dig the pit as deep as the plants' roots and keep the pit sides as vertical as possible. Make the pit large enough to avoid burning the surroundings. Patting mineral soil around the perimeter of the pit and keeping the perimeter moist can also help avoid scorching. After having the fire and cleaning out ashes, replace the soil and sod, making sure there are no air pockets. Water the site and remove evidence of disturbance.

PROBLEM ADDRESSED AND RATIONALE

Proliferation of campsites. This practice is a means of building a campfire in dense vegetation, with minimal disturbance. Where disturbance is minimized, the probability of creating a new campsite is reduced.

NEGATIVE CONSEQUENCES

Without question, this practice is the best way to minimize campfire impacts in areas of dense vegetation. The probability of the practice being ineffective and leaving a fire scar is high, however. Vegetation can be severely injured while being moved, it can dry out while being stored, and it can fail to grow after being replaced. Campfires should be built in a place without dense vegetation or they should not be built at all.

FREQUENCY OF RECOMMENDATION

Uncommon.

CONCLUSION

This practice was advanced as a way to minimize campfire impacts in places with dense vegetation. The National Outdoor Leadership School, which was involved in the initial development of this procedure, no longer uses the technique. Reexamination of old fires revealed frequent lack of success. The simple solution to the problem of avoiding impact is to not camp on dense vegetation on nights when a campfire is desired.

4. DISPOSE OF HUMAN WASTE IN A LATRINE

DESCRIPTION	Dispose of human waste in a single latrine excavated to handle the human waste of the entire Party.
PROBLEM ADDRESSED AND RATIONALE	Human waste. Latrines are basically informal toilets established to concentrate waste in places where use is heavy and adequate dispersal of catholes is difficult.
NEGATIVE CONSEQUENCES	The difference between a latrine and a toilet is that each group digs its own latrine. In popular camping areas, proliferation of latrines becomes as much of a problem as proliferation of catholes. Moreover, the concentration of human waste in a latrine dramatically slows decomposition rates and attracts animals that dig up the latrine. The result is that latrines create more of a health hazard than individual catholes.
FREQUENCY OF RECOMMENDATION	Uncommon.
CONCLUSION	Latrines are generally recommended for large parties in popular camping places. Ideally, toilets should be provided in places where latrines seem like a good i&a. Where toilets are not provided, widespread dispersal of catholes (people may have to walk a long way from camp) is preferable to a latrine. The only other options are to go with a smaller group or to stay away from very popular camping areas. With few exceptions, digging a latrine will increase the health hazard

PRACTICES THAT ARE APPROPRIATE ONLY IN CERTAIN SITUATIONS

The following eight commonly recommended practices are appropriate in certain situations, but are inappropriate elsewhere. In each case, readers are referred to a recommended practice that describes situations where the practice is not appropriate.

1. **SELECT AN ESTABLISHED CAMPSITE.** This practice is appropriate in popular places with well-impacted campsites; it is not desirable in little-used places (see practice 24).
2. **SELECT AN UNUSED CAMPSITE.** This practice is appropriate in little-used places; it is inappropriate in popular places with well-impacted campsites (see practice 23).
3. **DO NOT CAMP ON HEAVILY USED CAMPSITES.** This practice is appropriate in little-used places; heavily used campsites should be used in popular locations (see practice 23).
4. **DISPERSE ACTIVITIES ON CAMPSITES.** This practice is appropriate when camping on previously unused sites in little-used places; it is not appropriate when camping on established, well-impacted campsites (see practice 32).
5. **CONCENTRATE ACTIVITIES ON CAMPSITES.** This practice is appropriate when camping on established, well-impacted campsites; it is not appropriate when camping on unused sites (see practice 34).
6. **BUILD FIRE IN AN EXISTING FIRERING.** This practice is appropriate when camping in popular locations with well-impacted campsites; it is inappropriate when camping in little-used places (see practice 42).
7. **AVOID BUILDING FIRE IN AN EXISTING FIRERING.** This practice is appropriate when camping in little-used places; it is inappropriate when camping in popular places with well-impacted campsites and established fire sites (see practice 41).
8. **DISMANTLE ALL FIRERINGS.** This practice is appropriate in little-used places and on little-impacted sites; it is inappropriate on established campsites that are likely to be used by other parties (see practice 49).

DEVELOPING LOW-IMPACT MESSAGES

The preceding section described each recommended practice individually. When putting together a low-impact message, it will be more effective to group individual practices and to weave discussions of rationale into statements of recommended practices. This makes it easier to convey the way of thinking and the ethic that is the ultimate goal of low-impact education.

Considerable creativity and writing skill are required at this stage. One example of an attempt to convey this way of thinking is the 1986 revision of the National Outdoor Leadership School's (NOLS) Conservation Practices (see appendix C). This revision was a cooperative effort between NOLS and the author to develop a set of recommended practices and rationale that incorporates the best available information. Other examples can be found in books--such as Hampton and Cole (1988) and Hart (1977)--and journal articles--such as Curtis (1982) and Wallace and DeBell(1982).

Tailoring the Message to Different Environments

The recommendations described in this report are general ones that apply across a range of different environments. Often, specific information is available about different environments that can make recommendations more effective. For example, in deserts, sand washes are among the most durable surfaces, while soils crusted with cryptogams (moss, lichen, algae, and fungus) are among the most fragile. At high altitudes snowfield turfs are durable, while heaths are quite fragile. The specificity of recommendations can be increased by developing different messages for different environments. In addition, the importance of various practices differs between environments. For example, campfire practices designed to avoid excessive use of firewood are particularly important in environments with low wood productivity,

Tailoring the Message to Different User Groups

such as timberline forests or deserts. Certain environments also offer unique opportunities for minimizing impact. For example, on coastlines, the effects of fires built below high tide will be removed by periodic tides. Low-impact guidelines for (1) deserts, (2) high altitude and high latitude areas, (3) travel on snow and ice, and (4) coastline areas have been developed for use in conjunction with the general NOLS Conservation Practices. These guidelines are presented in appendix D as examples of how general practices might be modified in certain environments. Similar guidelines might be developed for other environments, such as swamps or eastern forests.

Different types of users also present particular challenges and offer unique opportunities for minimizing impact. Stock users, for example, must be much more cautious than backpackers if they are to keep impact to low levels. Rafters and stock users, because they can carry specialized equipment, have the opportunities to reduce their impact to extremely low levels. Low-impact messages should be tailored to take advantage of these differences. There is no reason to burden backpackers with information about low-impact stock or raft use. Special considerations for some important user groups follow. Similar guidelines might be developed for other user groups, such as day hikers, anglers, and hunters.

Stock Users- Parties traveling with stock are particularly prone to causing problems with (1) deterioration of constructed trails, (2) creation of new trails, (3) deterioration of established campsites, (4) creation of new campsites, (5) visitor conflict, (6) deterioration of grazing areas, and (7) competition with wildlife. This potential reflects the greater bearing weight of stock, the tendency for shod hooves to churn up soil, the trampling damage associated with confining stock, and the consumption of forage by grazing stock. Key elements to low-impact stock use are care in grazing and in confining stock. It is also preferable for stock parties to keep to constructed trails and substantially impacted camping areas (which are able to tolerate use by stock parties without further deterioration), except where they are prepared to be especially careful. Practices specific to parties with stock were described in detail in a previous section.

Boaters-- Rafters, and to a lesser extent kayakers and canoers, can carry fire pans (to shield the soil from campfire impacts), charcoal briquets (to avoid having to collect firewood), portable toilets (for removing human waste), and containers (to carry out ash and charcoal from campfires). Boaters often can also minimize their impact by camping below the annual high water line. These environments are often quite resistant, and much of the impact that does occur is removed by yearly floods. For these reasons, boaters should generally cause less impact than other users (if they take advantage of these opportunities).

Large Parties- Large parties are particularly prone to causing problems with (1) enlargement of established campsites, (2) creation of new trails, (3) creation of new campsites, and (4) visitor conflict. Practices 26 (select a site that is large enough to accommodate your party) and 32 (confine tents and activities to already impacted areas) are critical to avoiding campsite enlargement. Advance planning to identify places with sufficiently large campsites is needed. The three latter problems can be avoided by breaking the party up into smaller groups for traveling and camping. These smaller groups can spread out. On trails, this will reduce the conflict that results when large parties are encountered. Off trails, smaller groups are less likely to create a new trail, particularly if they spread out when walking (practice 19). At little-used camping areas, groups should stay separate, except to meet on some durable spot. This separation, along with spreading out tents and activities (practice 34), should reduce the likelihood of new campsites developing.

Parties Planning To Have Fires- Parties planning to have wood fires must be more cautious than those that do not. All of the practices in the section on campfires (practices 37-50) apply only to these users. Such parties must use particular caution when camping in little-used places because it is so important to camouflage any disturbance (practice 36). It is easy, when having a campfire, to leave a long-lasting scar. Such evidence tends to attract subsequent use, a tendency that often results ultimately in the creation of new campsites.

Parties Traveling Cross Country- Established trails are designed to accommodate use with minimal problem; well-impacted campsites function in the same way. Parties that choose to travel cross country and camp in little-used places accept special responsibilities for low-impact use (practice 6). Undisturbed places can experience long-term damage very quickly. Large parties, parties with stock, and parties planning to build campfires must be particularly careful in such places. Much more knowledge and decision-making ability are

Tailoring the Message to Different Audiences and Media

required to select cross-country routes (practice 21) and campsites (practice 27) that can be used without leaving evidence of your passage. More care is also needed to spread out when hiking (practice 19) and camping (practice 34). Lengths of stay on campsites must also be short (practice 35).

Backcountry travel and campsite selection and behavior techniques differ so greatly between trail users and crosscountry hikers that separate materials might be worked up for each type.

It should be obvious that there is a large amount of information on low-impact use that must be communicated to visitors. The information in the NOLS Conservation Practices (appendix C) takes 10 single-spaced pages. Clearly, all of this information cannot be communicated to users with signs or even by information specialists at trailheads. Pamphlets, books, video demonstrations, workshops, and ranger contacts are all needed. We need to (1) decide which media are most effective for which messages, (2) identify the most effective media for different audiences, and (3) ultimately get all messages across effectively to all users. Messages need not only to communicate, but also to motivate visitors to adopt recommendations.

Unfortunately, information on how to communicate and motivate visitors is limited. A variety of educational media have been employed, but effectiveness has seldom been rigorously evaluated. Moreover, there has been little attempt to apply existing theory to this problem. A major research effort is needed to develop effective means of instilling a low-impact ethic.

Despite the importance of the topic, I will not attempt to summarize what is known about how to communicate with backcountry users. A major report, comparable in length and detail to this one, is warranted. Interested readers are referred to several articles that describe educational programs (Bradley 1979; Hart 1980) and a comprehensive review of alternative communication methods (Martin and Taylor 1981). Other worthwhile sources include Fazio's (1979) and Roggenbuck and Berrier's (1981) work evaluating the effectiveness of communication techniques, and Dustin's (1985) attempt to bring psychological theory to bear on the question of how to instill a wilderness ethic.

RESEARCH GAPS

In the "knowledge needs" category under each practice, a number of research gaps were identified. These gaps are listed below, along with brief descriptions. They are listed in an approximate order of priority, starting with those that will most improve the application of practices.

1. *The durability of different environments.* We need to evaluate the durability of different environments as places for off-trail hiking, low-impact campsites, campfire sites, and holding stock. This is a broad topic. A fair amount is already known (Cole 1987b; Kuss 1986), and we will never have all the answers; however, it is important to continually increase our knowledge. This topic is assigned highest priority because this is knowledge that should be used continually by backcountry users and it is capable of substantially reducing impact.

2. *Harassment and disturbance of animals.* We need to learn how serious animal disturbance is. We need to learn which species are affected, where and when disturbance occurs, and how behavioral alteration can reduce problems. This is a broad topic about which very little is known (see Boyle and Samson 1983 for an annotated bibliography). Although we do not know enough to be certain, it is likely that adoption of disturbance-avoiding behavior could reduce impact substantially.

3. *Impacts of packstock on grazing areas.* We need to learn more about the effects of grazing and trampling on meadows and grasslands. We need to understand the effect of differences in the amount, timing, frequency, and location of grazing. This would be useful in developing better guidelines for avoiding overgrazing, recommended maximum lengths of stay, and the need for supplemental feed. This topic is a broad one about which little is known.

4. *Water pollution problems.* We need to know more about the nature, severity, and causes of recreation-related water pollution. To what extent does camping close to lakes and other water bodies cause problems? Is soap or fecal contamination of waters a common problem? We know very little about recreational impacts on water in wilderness (see Herrmann and Williams 1987 for a review). Research results may not change recommended practices, but it is critical to evaluating the importance of practices taken to avoid problems.

5. *Visitor preferences for campsite attributes.* We need to know more about the attributes that visitors seek when selecting a campsite. Tradeoffs between attributes are often required. Recommendations that visitors seek campsites away from lakeshores are based on an assumption that visitors are willing to give up camping by a lake for more solitude away from the lake and the opportunity to visit less disturbed lakeshores. Is this assumption, and others that we make about visitor preferences, valid? We know a fair amount about certain visitor attitudes and preferences (Stankey and Schreyer 1987), but we know little about how they make tradeoffs. This knowledge is important to recommendations related to behavior intended primarily to maintain quality visitor experiences.

6. *Sources of visitor conflict.* We need to know more about behaviors that result in conflict between parties. We know that certain visitors object to large parties, parties with stock, and parties with pets. The prevalence of these sentiments and means of mitigating conflict should be explored. The importance of other sources of conflict—shooting guns, competitive events, and so on—should also be examined.

7. *Relationship between quality of experience (visitor satisfaction) and frequency of encounters.* Although frequently studied, this relationship remains poorly understood. The aspect of this relationship most relevant to low-impact practices is whether or not the positive benefits of fewer encounters in popular places and at popular times exceed the negative consequences of more frequent encounters elsewhere and at other times. These changes are likely results of attempting to shift use away from popular places and times.

8. *Relationships between campsite impact and use frequency, length of stay, and party size.* We need to learn, for different environments, how much use sites can support before concentrating camping on a few well-impacted campsites becomes a more effective strategy than dispersing use among many undisturbed sites. Related to this is need for a better understanding of how rapidly impact is caused by parties of various sizes. This would be useful in recommending more specific length-of-stay and party size limits. Much is already known at a general level about these relationships (see Cole 1987b for a review). More quantification is needed for specific vegetation types. While this is likely to improve specificity, the basic concepts presented in the practices should be relatively unaffected by results.

9. *Seasonal variation in vulnerability.* We need to learn, for different environments, for different parameters (such as soil and animals), and for different sources of impact (such as stock and hikers), how vulnerability varies seasonally. We also need to learn how much variation there is in seasonal differences from year to year. We need to learn how to evaluate and predict vulnerability so visitors can vary their routes and/or behavior to account for seasonal differences. We have some general knowledge about seasonal vulnerability (such as that soils are particularly vulnerable during spring snowmelt), but more specific information is needed.

10. *Campfire impacts and the effectiveness of alternative campfire construction techniques.* A better understanding of the nature and significance of the impacts associated with collecting firewood and burning it in campfires would help in evaluating the importance of campfire practices and deciding where particular care is needed (Cole and Dalle-Molle 1982). Tests of the effectiveness of various campfire construction techniques could improve recommendations about how to build low-impact campfires.

11. *Fecal decomposition rates.* We need a better understanding of how rapidly feces and pathogenic organisms decompose and how decomposition rates can be maximized. Certain microsites might prove to be better sites for decomposition than others. A better understanding of decomposition rates might indicate where toilets are needed and how widespread the dispersal of catholes must be. Some limited research suggests that we have not shown enough concern about disposal of human waste (Temple and others 1982).

12. *How type of sole influences amount of impact.* It is widely assumed that lug-soled boots cause more damage than soft-soled boots, particularly on campsites. No studies have succeeded in demonstrating a substantial difference between sole types. Although a relatively minor point, further research might corroborate the general recommendation to wear soft-soled shoes around camp.

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APPENDIX A. LIST OF RECOMMENDED PRACTICES

I. TRIP PREPARATION

A Clothes and Equipment

1. Choose clothing and equipment colors that blend with surroundings
2. Carry appropriate equipment

B. Party Size

3. Keep party size small

C. Where and When to Visit the Backcountry

4. Avoid trips where and when soils are wet and muddy
5. Avoid trips where and when animals are particularly vulnerable to disturbance
6. Avoid off-trail travel unless prepared to use extra care

II. GENERAL CONDUCT

A Pets

7. Keep pets under restraint or leave them at home

B. Noise Levels

8. Be quiet in the wilderness

C. Disturbance of Natural and Cultural Features

9. Minimize disturbance of natural features
10. Do not disturb cultural artifacts or archaeological sites

D. Disturbance of Animals

11. Avoid harassment of animals
12. Do not feed animals
13. Protect food from animals

III. BACKCOUNTRY TRAVEL

A Practices When Traveling on Existing Trails

14. Avoid walking on closed trails and/or developing user-created trails
15. Walk single file and keep to the main tread
16. Do not shortcut switchbacks
17. Take trailside breaks off trail on a durable site
18. Step off the trail, downslope, when encountering a stock party

B. Practices When Traveling Off Trail

19. Spread out when walking off trail
20. Do not mark cross-country routes
21. Choose a cross-country route that crosses durable surfaces
22. Use caution when ascending or descending steep slopes

IV. CAMPSITE SELECTION AND BEHAVIOR

A Guidelines for Campsite Selection

23. In popular locations, select a well-impacted campsite
24. In remote locations, select a previously unused campsite
25. Never camp on a lightly impacted campsite
26. Select a site that is large enough to accommodate your party
27. Select a durable site
28. Select a concealed campsite away from trails, occupied campsites, lakes, and other water bodies

B. General Campsite Behavior

29. Wear soft-soled shoes around camp
30. Minimize intentional site alteration and the building of structures
31. Avoid trampling vegetation

C. Campsite Behavior on Well-Established Campsites

- 32. On established campsites, confine tents and activities to already impacted areas
- 33. On established campsites, dismantle any structures you built and any other inappropriate structures; leave the site clean and attractive

D. Campsite Behavior on Previously Unused Sites

- 34. On previously unused sites, disperse tents and activities
- 35. On previously unused sites, keep lengths of stay short
- 36. On previously unused sites, camouflage any disturbance

V. CAMPFIRES

A. Places Where Campfires Are or Are Not Appropriate

- 37. Limit the use of campfires
- 38. Avoid fires where firewood is not plentiful
- 39. Do not build a fire where fire danger is high
- 40. Build fires on mineral soil where trees, roots, vegetation, or rocks will not be scarred
- 41. In places with well-impacted campsites, build fires in existing firerings or on tire scars
- 42. In places without well-impacted campsites, do not use existing firerings or scars; dismantle any rings

B. Firewood Gathering

- 43. Gather firewood away from camp; disperse your gathering
- 44. Use only dead and down firewood that you can break by hand

C. Fire Site Construction on Previously Unused Sites

- 45. On previously unused fire sites, build **fire** in a shallow pit or on a mound of mineral soil
- 46. Do not ring a fire with rocks

D. Campfire Use and Cleanup

- 47. Keep fires small
- 48. Burn charcoal to ash; soak ashes; scatter excess firewood
- 49. On preexisting fire sites, leave the firering clean and attractive; dismantle extra firerings
- 50. On previously unused fire sites, remove all evidence of the fire

VI. WASTE DISPOSAL AND SANITATION

A. Disposal of Litter and Organic Wastes

- 51. Pack out nonorganic litter (or burn readily burned litter)
- 52. Pick up other people's litter
- 53. Pack out or burn organic garbage (or scatter fish viscera)

B. Disposal of Human Waste

- 54. Use toilets if provided
- 55. Dispose of human waste in a properly located cathole

C. Bathing and Washing

- 56. Use biodegradable soap in small amounts, if at all
- 57. Bathe, wash, and dispose of waste water away from water bodies and campsites

VII. ADDITIONAL PRACTICES FOR PARTIES WITH STOCK

A. Equipment and Trip Reparation

- 58. Use properly trained stock
- 59. Carry appropriate equipment
- 60. Minimize the number of stock

- B. Practices When Traveling on Existing Trails
 - 61. Stock should stay on established trails as much as possible
 - 62. Remove trail obstacles instead of skirting them
 - 63. Lead stock on the trail, rather than loose-herd them
 - 64. Tie stock off trail, on a durable site, when taking a break
- C. Campsite Selection
 - 65. Avoid places that have already been heavily grazed
- D. Campsite Behavior
 - 66. Keep stock off campsites as much as possible
 - 67. Keep lengths of stay at one place short
- E. Watering, Feeding, and Grazing Stock
 - 68. Water stock downstream from drinking sources on a durable spot
 - 69. Carry an appropriate amount of weed-free supplemental feed
 - 70. Place feed and salt on a tarp or in a feedbag or container
 - 71. Minimize confinement of stock when grazing; move picketed stock frequently
- F. Confining Stock
 - 72. Use existing hitch rails and corrals where available
 - 73. Where confinement is necessary, use a hitch line on a durable site away from water
 - 74. Avoid tying stock to trees, particularly small trees
- G. Cleanup
 - 76. Renovate pawed-up areas; scatter manure; remove picket pins and excess feed and salt

APPENDIX B: SOURCE MATERIALS ON LOW-IMPACT PRACTICES

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3. Simer, P.; Sullivan, J. 1983. The National Outdoor Leadership School's wilderness guide. New York: Simon and Schuster. 345 p.
4. Waterman, L.; Waterman, G. 1979. Backwood ethics: environmental concerns for hikers and campers. Boston: Stone Wall Press. 175 p.
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7. U.S. Department of Agriculture, Forest Service, White River National Forest; Roaring Fork Group of the Sierra Club. 1976. Wilderness ethic [for use in the Maroon Bells-Snowmass Wilderness]. Glenwood Springs, CO. Foldout.
8. U.S. Department of Agriculture, Forest Service, Inter-mountain Region. 1982. Leave no trace (wilderness skills program). Ogden, UT. 26 p.
9. Alberta Recreation, Parks and Wildlife, Recreation Development Division. [n.d.]. Minimize your impact during horseback trips. Edmonton, AB. 21 p.
10. Backcountry Horsemen. [n.d.]. Back Country Horsemen's guidebook. 2d ed. Columbia Falls, MT: Hungry Horse News. 60 p.
11. U.S. Department of Agriculture, Forest Service, Pacific Northwest Region. 1970. Horse sense on backcountry pack trips. Portland, OR. 14 p.
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13. Floyd Wilson Wilderness Education Foundation. [n.d.]. A code of conduct for those who enter wilderness. Denver, CO. 4 p.
14. U.S. Department of the Interior, Sequoia/Kings Canyon National Parks [and the Inyo, Sequoia, and Sierra National Forests]. 1976. Stalking the wilderness experience. Three Rivers, CA. Foldout.
15. U.S. Department of Agriculture, Forest Service, Northern Region. 1972. Wilderness manners. Missoula, MT. Foldout.
16. U.S. Department of Agriculture, Forest Service, Northern Region. 1983. Keeping the 'wild' in wilderness. Missoula, MT. [Single sheet for each wilderness in the region.]
17. U.S. Department of Agriculture, Forest Service, Northern Region. 1978. Selway Bitterroot Wilderness primer. 2d ed. Publ. RI-78-23. Missoula, MT. 89 p.
18. Miller, Bob. 1973. Suggestions for using horses in the mountain country. Bozeman, MT: Montana State University. 13 p.
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21. Cole, D.; Benedict, J. 1983. Coverups: how to pick a campsite you can leave without a trace. Backpacker. 2(51): 40,44,87.
22. U.S. Department of the Interior, National Park Service. Shenandoah National Park. [n.d.]. Exploring the backcountry. Luray, VA Foldout.
23. Nelson, Keith. [n.d.]. No-trace camping interest group. Eugene, OR: University of Oregon, Outdoor Program. 3 p.
24. Manning, R. E. 1980. Going light"-new meaning for an old term. Parks. 4(4): 9-12.
25. Wallace, A.; DeBell, G. 1982. Ten tips on low-impact camping. Sierra. 67(2): 57-59.
26. Curtis, S. 1982. Walking lightly. National Parks. 56(5-6): 30.
27. Hart, P. 1980. New backcountry ethic: leave no trace. American Forests. 86(81): 38-41, 51-54.
28. Berliner, W. 1979. Hiking and camping naturally. East West Journal. August: 10-13.
29. Stevens, J. 1983. Wilderness etiquette. Signpost. September.
30. National Outdoor Leadership School. 1978. NOLS conservation practices. Lander, WY. 10 p.
31. Cockrell, D.; Viles, C. 1985. Report on the NOLS conservation practices. Lander, WY: National Outdoor Leadership School; Unpublished report. 27 p.

32. National Outdoor Leadership School [various authors]. 1978. Recommendations for NOLS regional conservation practices. Lander, WY. 27 p.
33. U.S. Department of Agriculture, Forest Service, Northern Region. 1983. Keeping the 'wild' in wilderness. Missoula, MT. Foldout.
34. U.S. Department of Agriculture, Forest Service, Tonto National Forest. [n.d.]. Backcountry ethics. Phoenix, AZ. Foldout. [Similar foldouts for other forests in the Southwestern Region.]
35. U.S. Department of Agriculture, Forest Service, Shoshone National Forest. 1977. Wildland ethic. Cody, WY. 17 p.
36. U.S. Department of Agriculture, Forest Service, Rocky Mountain Region; Colorado Mountain Club. [n.d.]. An outdoor code. Lakewood, CO. Foldout.
37. U.S. Department of Agriculture, Forest Service, Gila National Forest. [n.d.]. The no trace challenge-guidebook for: the "hoof and frame" wilderness skills trail. Silver City, NM. 70 p.
38. U.S. Department of Agriculture, Forest Service, Pacific Northwest Region. 1979. Without a trace: the wilderness challenge. Portland, OR. Foldout.
39. U.S. Department of Agriculture, Forest Service, Mt. Hood National Forest. [n.d.]. Wilderness ethic. Gresham, OR. Foldout.
40. Department of the Interior, National Park Service. Mt. Rainier National Park. [n.d.]. Fragile . . . handle with care. Ashford, WA 19 p. [plus descriptions to go with a slide set].
41. U.S. Department of Agriculture, Forest Service, Wallowa-Whitman National Forest. [n.d.]. The wilderness skills trail. Baker, OR. 13 p.
42. U.S. Department of Agriculture, Forest Service, Pacific Northwest Region. [n.d.]. Minimum impact camping and hiking or rules and regulations vs. freedom. Portland, OR. 3 p.
43. U.S. Department of Agriculture, Forest Service, White River National Forest. [n.d.]. Important ethics for areas in the Maroon Bells-Snowmass Wilderness. Glenwood Springs, CO. 2 p.
44. U.S. Department of Agriculture, Forest Service, Pacific Northwest Region. [n.d.]. Pickets and hobbles. Portland, OR. Foldout.
45. U.S. Department of Agriculture, Forest Service, Green Mountain National Forest. [n.d.]. The Lye Brook Wilderness. Rutland, VT. 2 p.
46. U.S. Department of Agriculture, Forest Service, Eldorado and Stanislaus National Forests. [n.d.]. Mokelumne Wilderness. Placerville, CA Foldout.
47. U.S. Department of Agriculture, Forest Service, Rogue River National Forest; U.S. Department of the Interior, Bureau of Land Management. 1980. River etiquette, Rogue National and Scenic River. Medford, OR. Foldout.
48. U.S. Department of Agriculture, Forest Service, Siskiyou National Forest. 1980. A guide to the Kalmiopsis Wilderness. Grants Pass, OR. 20 p.
49. U.S. Department of Agriculture, Forest Service, Intermountain Region. 1978. High Uintas Primitive and related areas. Ogden, UT. Foldout.
50. U.S. Department of Agriculture, Forest Service, Lolo National Forest; and Montana Power Company. [n.d.]. Rattlesnake National Recreation Area and Wilderness. Missoula, MT. Foldout.
51. U.S. Department of the Interior, Bureau of Land Management, John Day River. [n.d.]. Floating . . . the John Day River. Prineville, OR. Foldout.
52. U.S. Department of Agriculture, Forest Service, California Region. [n.d.]. The wilderness traveler. San Francisco, CA Foldout.
53. U.S. Department of Agriculture, Forest Service, Pacific Northwest Region. 1980. Evaluating your no-trace camping experience. Portland, OR. Foldout.
54. U.S. Department of Agriculture, Forest Service, Alaska Region. [n.d.]. Alaska solitude. Leaflet 159. Juneau, AK. 37 p.
55. U.S. Department of Agriculture, Forest Service, Pacific Northwest Region. 1980. Wilderness visitor permit information for National Forests in Oregon and Washington. Portland, OR. Foldout.
56. Recreational Equipment Incorporated. [n.d.]. Minimum impact camping. Seattle, WA Foldout.
57. U.S. Department of the Interior, Bureau of Land Management, Bear Trap Canyon Wilderness. [n.d.]. Butte, MT. Foldout.
58. U.S. Department of Agriculture, Forest Service, Superior National Forest. 1984. Welcome: BWCA Wilderness visitor information. Duluth, MN. Foldout.

59. Backcountry Horsemen of Washington, Inc. [n.d.]. Horse use in the backcountry. Seattle, WA 5 p.
60. U.S. Department of the Interior, National Park Service, Great Smoky Mountains National Park. 1982. Great Smoky Mountains Trail Guide. Gatlinburg, TN. Foldout.
61. U.S. Department of Agriculture, Forest Service, Monongahela National Forest. 1985. Cranberry Wilderness. Elkins, WV. Foldout.
62. U.S. Department of Agriculture, Forest Service, Monongahela National Forest. 1984. Dolly Sods Wilderness and Scenic Area. Elkins, WV. Foldout.
63. U.S. Department of Agriculture, Forest Service, Monongahela National Forest. 1984. Laurel Fork Wilderness. Elkins, WV. Foldout.
64. U.S. Department of the Interior, Bureau of Land Management, Lewistown District. [n.d.]. Upper Missouri National and Scenic River. Lewiston, MT. Foldout.
65. U.S. Department of the Interior, Bureau of Land Management, Paria River. 1983. Hiker's guide to the Paria. Kanab, UT. Foldout.
66. U.S. Department of the Interior, Bureau of Land Management, Moab District. 1981. River etiquette. Moab, UT. Foldout.
67. U.S. Department of the Interior, National Park Service, Lassen National Park. 1985. Lassen Park Guide. Mineral, CA 8 p.
68. The North Face (in cooperation with U.S. Department of the Interior, National Park Service). 1981. Minimum impact camping. Berkeley, CA 16 p.
69. U.S. Department of the Interior, National Park Service, Yellowstone National Park. 1981. Beyond road's end. West Yellowstone, MT. 20 p.
70. U.S. Department of Agriculture, Forest Service, Hoosier National Forest. 1981. Two Lakes Loop hiking trail. Bedford, IN. Foldout.
71. U.S. Department of the Interior, National Park Service, Zion National Park. [nd.]. Hiking in the backcountry of Zion National Park. Springdale, UT. 2 p.
72. U.S. Department of the Interior, National Park Service, Buffalo National River. [n.d.]. Backpacking and wilderness hiking at Buffalo River. Harrison, AR. Foldout.
73. U.S. Department of the Interior, National Park Service, Everglades National Park. 1984. Wilderness camping in Everglades National Park. Homestead, FL. 2 p.
74. U.S. Department of the Interior, National Park Service, Canyonlands National Park. [n.d.]. Welcome to the Needles District. Moab, UT. 1 p.
75. U.S. Department of the Interior, National Park Service, North Cascades National Park. 1984. Touch the wilderness gently. Sedro Wooley, WA Foldout.
76. U.S. Department of the Interior, National Park Service, North Cascades National Park. [n.d.]. Heading for the mountains? Sedro Wooley, WA 7 p.
77. U.S. Department of Agriculture, Forest Service, Gunnison National Forest. 1986. West Elk Wilderness. Delta, CO. Foldout.
78. U.S. Department of Agriculture, Forest Service, Desoto National Forest. [n.d.]. Black Creek Trail. Jackson, MS. Foldout.
79. U.S. Department of Agriculture, Forest Service, 1976. Woodsy Owl on hiking and backpacking. FS-313. Washington, DC. Foldout.
80. U.S. Department of Agriculture, Forest Service, Southern Region. [n.d.]. Low impact camping. Atlanta, GA 2 p.
81. University of Idaho, Department of Wildland Recreation Management [In cooperation with United States Department of the Interior, Bureau of Land Management, Cottonwood Resource Area]. [n.d.]. River use ethics. Moscow, ID. Foldout.
82. U.S. Department of Agriculture, Forest Service, Mark Twain National Forest. 1985. Hercules Glades Wilderness. Rolla, MO. Foldout.
83. U.S. Department of the Interior, Bureau of Land Management, Boise District. 1n.d.l. Minimum impact camping, Lower Salmon, Bruneau and Jarbidge Rivers. Boise, ID. Foldout.
84. US. Department of the Interior, National Park Service, Isle Royale National Park. 1985. Isle Royale: camping, hiking, boating. Isle Royale Natural History Association. Houghton, MI. Foldout.
85. U.S. Department of Agriculture, Forest Service, Snoqualmie National Forest. 1n.d.l. Snow Lake management plan: the responsibility of freedom. Seattle, WA. Foldout.
86. U.S. Department of Agriculture, Forest Service, Pacific Northwest Region. 1980. Minimum impact camping and hiking. Portland, OR. Foldout.
87. Recreational Equipment Incorporated [in cooperation with United States Department of the Interior, National Park Service, Mt. Rainier National Park). 1983. Brochure on human waste disposal at high elevations. Seattle, WA. Foldout.

88. U.S. Department of Agriculture, Forest Service, Nez Perce National Forest. [n.d.]. Environmental outfitting. Grangeville, ID. 17 p.
89. U.S. Department of Agriculture, Forest Service, Custer National Forest. 1980. Absaroka-Beartooth Wilderness trails. Billings, MT. 1 p.
90. Appalachian Mountain Club. [n.d.]. Low impact use. Boston, MA. Foldout.

APPENDIX C: NOLS CONSERVATION PRACTICES

If we are to maintain the ecological integrity and quality experiences that backcountry provides, it is imperative that every visitor strives to minimize his/her impact both on the land and on other visitors. Otherwise management of backcountry will become increasingly dominated by rules, regulations, and restriction of access and use. The National Outdoor Leadership School has pioneered the teaching and development of practical conservation techniques, designed to minimize impact, since 1965.

We recommend the following practices as a guide to minimizing the impact of your backcountry visits. This guide represents a synthesis of our observations and experience with human impact in the backcountry, as well as the results of research on recreational impact and its causes. Under each major topic, we briefly discuss factors to consider when making judgements about how to minimize impact and the rationale behind recommended practices. These sections are followed by a list of specific practices.

NOLS welcomes comments and suggestions for further modifications to these conservation practices. Before traveling into the backcountry, we recommend that you check with local officials of the Forest Service, Park Service, Fish and Wildlife Service, Bureau of Land Management, or other managing agency for advice and regulations specific to the area.

Minimum impact backcountry use is an ethic and way of thinking. It depends more on attitude and awareness than on rules and regulations. Conservation practices must be flexible and tempered by judgement and experience. Consider the variables of each place-soil, vegetation, wildlife, moisture level, the amount and type of use the area receives and the overall effect of prior use then use these observations to determine which recommended practices to apply. Minimize your impact on the land and on other visitors, but be sure to enjoy your visit as well.

A. BACKCOUNTRY TRAVEL

When traveling in the backcountry, care is required to minimize disturbance of both other visitors and the environment. Disturbance of other visitors is minimized when contacts are infrequent, party size is small, and behavior is considered appropriate by others. Impacts on wildlife, soil and vegetation can be minimized by walking on constructed trails that are already highly disturbed and, in many cases, have been designed to accommodate heavy use. Unfortunately, use of existing trails increases contact with other visitors. Consider the tradeoff between social and ecological impacts when deciding whether to travel by trail or cross country. The impacts associated with cross country travel are minimized when group size is small, routes are carefully selected to avoid fragile terrain and critical wildlife habitat and special care is taken to avoid disturbance.

Specific practices are as follows:

1. Travel quietly in the backcountry, whether hiking by trail or cross country. You will be more aware of your environment, wildlife will be less disturbed, and other visitors will appreciate the solitude.
2. Brightly colored clothes and equipment have limited advantages in the backcountry, despite their great appearance in store windows. To minimize the likelihood that others will see you and your camp, attempt to wear and carry earth colored clothes and equipment, particularly tents.

3. If you are camping with a large group, hike in groups of no more than **4-6** people. Four is an optimum number, especially for cross country travel, because in case of sickness or injury one person can stay with the victim while two people go for help. A group of four is small enough to minimize impact on other visitors and on the environment when traveling cross country. Use judgement in breaking your group into smaller units to minimize impacts and maximize individual enjoyment and self-reliance.
4. If possible, visit the backcountry during seasons or days of the week when use levels are low. This should be tempered with a concern for avoiding travel when the environment is particularly fragile (for example, during snowmelt when trails are muddy). Similarly, by visiting places that receive little use, contact with others will be minimized. Again, this should be tempered by a concern for avoiding disturbance of such little-used and little-impacted places. Large groups can disturb these places rapidly.
5. Pick up all of your litter and any of that left by others that you can. On the way out-when your pack is light-try to pick up a little extra.
6. Allow others a sense of discovery by leaving rocks, plants and other objects of interest as you found **them**. Enjoy an occasional edible plant, but be careful not to deplete the surrounding vegetation or to disturb plants that are either rare or do not reproduce in abundance (such as many edible lilies).
7. Respect the needs of birds and other animals for undisturbed territory. When tracking wildlife for a photograph or a closer look, stay downwind, avoid sudden movement, and never chase or charge an animal. Avoiding disturbance is particularly important at birthing or nesting sites and at watering or feeding grounds, especially during times of year, such as winter, when animals are already stressed. Find out as much as you can, before entering the area about species, places and times when disturbance is likely. Some animals may be quite curious, but resist the temptation to feed them. Even in low-use areas, feeding wildlife can alter feeding habits, migration patterns and reproduction levels, ultimately resulting in unnatural behavior, population structure and species composition.
8. When following existing trails, walk single-file on the designated path. Walking outside the tread, to walk abreast or to avoid rocks or mud, breaks down the trail edge and widens the trail. It can also lead to the development of multiple trails. As with muddy stretches, snowbanks should be crossed, rather than skirted, to avoid creation of additional paths. Shortcutting switchbacks causes erosion and gullying. If a trail is impassable, walk on hard surfaces (such as rock, sand or snow) as much as possible and notify the agency officials responsible for that area.
9. When taking a break along the trail, move off the trail some distance to a durable stopping place. Here you can enjoy more natural surroundings and other parties can pass by without contact. Durable stopping places include rock outcrops, sand, other non-vegetated places and sites with durable vegetation, such as dry grasslands.
10. When you meet a stock party on the trail, allow them plenty of room, as stock are frightened easily. The entire party should move off to the same side of the trail, if possible the downhill side, and stand quietly until the stock party passes. Sometimes it helps to talk, in a low voice to the first rider, so the horses have advance notice of your presence.

11. Cross country travel is acceptable if groups are small (no larger than 46) and fragile areas can be avoided. Cross country travel is undesirable where user-created trail systems are developing, in wet places, on steep and unstable slopes, on crusted desert soils and in places where wildlife disturbance is likely. It is most desirable on rock, sand, snow and ice or stable non-vegetated surfaces.
12. When traveling cross-country it is generally best to spread out rather than have everyone follow the same route. This will minimize the amount of trampling any place receives and avoid the creation of undesired trails. In some places it is not practical to spread out; avoid such routes if other groups are likely to follow in your footsteps and particularly if incipient paths are developing. In extremely fragile places, such as on cryptogam soils, it is best to walk single-file so only one trail is created. Cross-country travel should be avoided in such fragile places.
13. Do not blaze trees, build cairns or leave messages in the dirt. Such markers may be confusing and they detract from other visitors' sense of discovery.
14. In steep terrain it is least damaging to ascend or descend on rock outcrops or snow. On soil-covered surfaces it is less damaging to ascend than to descend steep slopes. If slopes are so steep that it is necessary to dig toes and heels into the soil to get a grip, some other route should be located, if possible. Spreading out can also reduce damage. When descending loose scree slopes, move slowly and cautiously. Rapid descents can move sizeable quantities of scree downslope. This erosion is undesirable and should be minimized.
15. If traveling with pets (this is prohibited in many National Park Service areas and discouraged in many other areas), keep them under restraint. They should never be allowed to chase wildlife or harass other users and barking should be discouraged. Pets should be left at home.

B. CAMPSITE SELECTION AND USE

Selecting an appropriate campsite is probably the most difficult and perhaps the most important aspect of low impact backcountry use. It requires the greatest use of judgement and information and often involves making trade-offs between minimizing ecological or social impacts. A decision about where to camp should be based on information about the level and type of use in the area, the fragility of vegetation and soil, the likelihood of wildlife disturbance, an assessment of previous impacts and your party's potential to cause or avoid impact.

In selecting a campsite, the objective is to choose one that will not be damaged by your stay. Generally it is best to camp either (1) on apparently undisturbed sites (if your stay will cause little impact and, therefore, not encourage subsequent use by other parties) or (2) on sites that are so highly impacted that further use will cause no additional impact. Lightly impacted sites—those that have obviously been used but with a substantial amount of vegetation surviving on-site—should always be avoided; such sites will deteriorate rapidly with further use, while if unused they should recover rapidly.

When selecting an undisturbed site, choose one that either has no vegetation or a durable vegetation cover. When selecting a high impact site, choose one that is concealed and, if possible, in thick forest duff (the dark layer of decomposing leaves, needles and twigs that lies on top of the lighter, grittier mineral soil). On such sites, little vegetation can survive use, but exposure of mineral soil will be less pronounced on sites with thick organic horizons. If mineral soil exposure is minimal, soil compaction and erosion will also be minimized. Other considerations when selecting a site include camping away from critical wildlife habitat, particularly water holes, away from trails and other campers and, in popular areas, away from "beauty spots" and lakes and streams.

Appropriate camping behavior depends upon whether a pristine or a high impact site has been selected. On pristine sites it is best to spread out tents, avoid repetitive traffic routes and move camp every night. The objective is to minimize the number of times any part of the site is trampled. On high impact sites, tents should be concentrated on already impacted areas, as should traffic routes, and multi-day stays are acceptable. The objective is to confine impact to places that have already been impacted and avoid enlargement of the site.

Specific practices of, first, site selection and then camping behavior are as follows:

1. Obey any regulations in the area related to campsite selection. Select either a pristine site or a high impact one. A pristine site is one that shows no evidence of previous use. A high impact site is one on which vegetation has been removed from an area large enough to accommodate your group. Avoid selecting a pristine site in popular areas or a high impact site in an infrequently used area. Select a high impact site for large groups, multi-day stays or when you want to build a fire (if there is abundant firewood in the area). Allow enough time and energy to select an appropriate site.
2. Selection and use of pristine sites
 - a. Select a site, well away from high impact areas, that shows no evidence of previous use and is unlikely to be used after you leave. Durability of the ground surface is the most important consideration in determining exactly where to set up tents and the "kitchen". Non-vegetated areas, such as slickrock, rock outcrops, gravel bars, beaches and snow, are best. Forest duff is acceptable if it is possible to not crush any plants or seedlings (forest-floor vegetation is highly fragile). Grassy areas and dry meadows can also make good pristine campsites. They are quite resistant and capable of recovering rapidly from the effects of one night of low-impact use. When deciding whether or not to camp in a meadow, consider whether you will impact other users or wildlife. Places to avoid, if possible, include vegetated forest-floors, sites with low-growing shrubs (particularly those at or above timberline), moist areas, and crusted desert soils.
 - b. In setting up camp, disperse tent sites and the "kitchen" on durable sites. Wear "soft" shoes around camp. Minimize activity around the kitchen and places where packs are stashed and watch where you walk to avoid crushing vegetation. Take alternate paths to water and minimize the number of trips to water by carrying water containers. Avoid using the same general area for more than one night. Dispersal of sites, traffic routes and activities and short stays are particularly important for large groups, which must be especially careful not to disturb the site. When leaving, camouflage the area by covering any scuffed-up places with duff or other native materials (see under Fires and Stoves for more).
3. Selection and use of high impact sites
 - a. Select a site that has already lost most of its vegetation cover. If possible, avoid those with obvious soil erosion and with root exposure and mutilations on most trees, as well as those that have coalesced into large campgrounds. Such sites are poorly located and/or have been used improperly in the past; they should probably be permanently closed to use. In very popular areas, however, use levels are so high that it is best to use these severely impacted sites. If possible, choose screened, forested sites, with thick organic horizons. Otherwise choose sites that naturally lack vegetation—those that are gravelly, sandy or have exposed mineral soil. Avoid camping in meadows and the zone between forest and snow. The visual impact of campsite deterioration is severe in

these particularly scenic areas. Avoid camping close to water sources, trails, other campers and "beauty spots". The choicest camping spots are often prime locations for other people's enjoyment of the area, so take a little extra time to seek out a more "out-of-the-way" site.

- b. In setting up camp, do not sprawl out. Set up tents and the kitchen" in places that have already been impacted, with well-developed paths between tents and the "kitchen". Avoid enlarging the site and try not to step on tree seedlings. When leaving camp, make sure that it is clean, attractive and will be appealing to the next group to use the area.
4. On all sites, leave the area as you found it. Do not dig trenches for tents, cut standing trees or branches or pull up plants or embedded rocks to make a pleasant camp. If you clear the sleeping area of surface rocks, twigs or pinecones, replace these items before leaving. On high impact sites, it is appropriate to clean up the site and dismantle inappropriate user-built facilities, such as multiple firerings, constructed seats, tables, etc. However, properly-located and legal facilities, such as a single firering in many areas, should be left. Dismantling them will cause additional impact, because they will be rebuilt, with new rocks, and impact a new area
5. A backcountry camp should be organized. If you have laundry to dry or equipment to air out, make sure these items are not in sight of other campers or hikers, especially around lakeshores or in open meadows. Make sure your food is protected from animals. This is especially important in bear country.

C. FIRES AND STOVES

Fires should be used sparingly, as they are among the most serious visual impacts in the backcountry. They can also sterilize the soil locally and collection of firewood can scar live trees and snags and deplete large decaying wood in the soil. Large decaying wood plays an important and irreplaceable role in the ecosystem-in water and nutrient conservation and as a substrate for biological activity; smaller pieces of wood are less critical. Fires can also escape and bum large areas. Avoid use of ties when fire hazard is high. Finally, many areas have regulations that control the use of fire; be certain to know and respect regulations.

Use of stoves is always preferable to building a campfire. Always carry a stove; use it for most if not all cooking; and only build a fire where it is safe and will not cause further damage or deplete wood supplies. Campfires are acceptable at high impact sites in existing firerings or places where fires have been built-but only if there is abundant dead wood on the ground. Fires should be avoided in popular areas in the desert or near timberline, because wood regenerates so slowly in these places. On pristine sites, fires are less desirable. Although firewood may be abundant, fires on undisturbed sites can damage soil and vegetation, as can concentrated trampling around the fire. In popular areas there is no excuse for building a fire where one has never been built before. In remote places, impact can be minimized if fires are carefully constructed on sandy sites or sites with abundant mineral soil, or below the high water line along water courses or on the coast. With special care fires can also be built on rocks or in dense vegetation (see below for further description of techniques), but use of these latter techniques should be minimized.

When building a campfire on a pristine site, care must be taken in locating the fire, constructing it, selecting and burning wood, avoiding trampling around the fire and in cleanup. When building fires in existing rings on high impact sites, only care in selecting and burning wood and a moderate amount of cleanup is necessary.

Specific fire-building practices are as follows:

1. Locate campfires where they are safe, damage will be minimal and cleanup and camouflaging of the site will be easiest.
 - a. Always build fires far from tents, trees, branches, root systems and large rocks that might be damaged by sparks and heat or blackened by smoke.
 - b. When looking for a potential fire site in a pristine area, the usual types of surfaces to choose between are vegetation, rock, duff (the dark surface layer of decomposing leaves, needles and twigs) and bare mineral soil (the lighter and grittier soil layers beneath the duff). In order of preference, choose a surface of mineral soil, thin duff (less than 2-3 inches thick), sparse vegetation, or a flat rock. Never build a fire in thick duff because the danger of fire spreading is great. Avoid fires in dense vegetation because it is difficult to not damage the vegetation.
 - c. On a previously-used site where fires have been built in several places, select the fire scar that is most pronounced and/or is in the best location (in terms of the criteria in a and b above). If you can, cleanup all other firerings and scars (see Practice 4b below). This cleanup will more than compensate for the effect of another fire on the site.
2. Construction. Fires can be built either on a mound or in a pit. Mound fires are preferable if an adequate supply of sand or mineral soil can be found without damaging the source area. Regardless of fire type or location, avoid blackening rocks by cooking on a stove, using a grill with folding legs, or hanging pots from a dead branch.
 - a. Mound fire: Spread a layer of soil about 6 inches deep on top of the ground surface, over an area larger than the fire will occupy. Build the fire on the soil. Mound fires are most likely to be built on mineral soil, duff or rock.
 - b. Pit fire: In mineral soil, simply dig a shallow pit, several inches deep. Build the fire in the pit. Where there is a thin duff layer or sparse vegetation, clear the duff down to mineral soil from a circle several feet in diameter; build the fire in a shallow pit in the center of the circle of mineral soil. If a fire absolutely must be built in dense vegetation, dig a pit down to mineral soil and as deep as the plant's roots, if possible. Keep the pit sides as vertical as possible. Make sure it is not so deep that air circulation is hindered. Remove the plants and soil in as large a block as possible and place them neatly some distance from the pit. Make sure the pit is large enough to avoid burning the adjacent vegetation. This can also be prevented by patting mineral soil around the firepit perimeter and by keeping the perimeter moist. The removed sod should also be kept moist.
3. Select firewood from small diameter wood lying loose on the ground. If wood is not small and dry enough to break by hand it should not be used. Do not bring saws or axes. Gather wood some distance from camp on existing sites and always leave some wood, so the area does not look denuded. Collect only enough wood for a small fire; do not stockpile. Avoid burning food scraps and plastic. Complete combustion is difficult, wastes wood and transfers large quantities of heat into the soil; incomplete combustion makes cleanup difficult.
4. Cleanup
 - a. At least 30 minutes before finishing with the fire, begin to burn remaining wood and charcoal to ash. Heap coals and unburned pieces of wood where the heat is greatest and keep adding very small pieces of

wood until only white ash remains. Soak ash with water and crush any charcoal remnants to powder. Scatter any excess firewood away from the site.

- b. If using a preexisting fire site, leave a small clean firering to attract the next user. If large quantities of ash were generated by you or previous users, scatter it some distance from the campsite. Any excess blackened rocks-from an over-built firering or from multiple firerings-should be returned to their original locations, if possible, or scattered some distance from the camp.
- c. If using a pristine site, scatter ash widely. If using a mound fire, scatter the soil and ash and camouflage the surface with mineral soil or litter and duff (whatever matches the surroundings). If the mound was built on a rock, rinse the rock off. If using a pit, fill it in and camouflage the site. For pits in dense vegetation, make sure there are no air pockets underneath or around sod blocks to cause drying of roots or subsequent settling of the soil. Water the site well to help recovery and landscape the area.

D. SANITATION

Proper disposal of human waste is difficult, particularly in heavily used areas where toilets are not provided. Only footprints are more difficult not to leave in the backcountry. The most important objectives when deciding on how to dispose of waste are (1) to minimize the chance that other people will find it, (2) to minimize the chance that waters will be polluted and (3) to maximize the rate of decomposition. In the past, objectives 1 and 2 have been met by recommending burial of feces in catholes or latrines (for large groups) well away from water bodies. The oft-stated contention has been that decomposition by soil organisms would be rapid. Unfortunately, recent research has found that this is not always the case. In the Rocky Mountains, pathogenic organisms survived in buried feces for a year or more. Moreover, survival was little affected by either depth of burial or the type of site where the feces was buried. It is still generally best to deposit feces in catholes, but the slow decomposition rate emphasizes the need to disperse catholes widely and far from water, campsites and other frequently used places.

Decomposition is most rapid when feces is left at the surface in the open sunlight. It is least rapid when concentrated (as in a latrine) or when deposited in soils that are cold, sterile or wet. Therefore, in remote places where there is little chance that others will find your feces, it may be desirable to leave it at the surface. In more popular places, it will be necessary to bury feces in catholes or, as a last resort (for large groups) to concentrate it in latrines. Considerable judgement must be exercised to determine if surface deposition is acceptable and whether to use a latrine or individual catholes.

Urination is less of a problem. It has little direct effect on vegetation or soil. It does attract salt-craving wildlife, however, and they can defoliate plants and dig up soil. Therefore, it is best to urinate on rocks and in places where urine is unlikely to attract wildlife.

The primary consideration with washing yourself or your clothes is to avoid contamination of water supplies.

Specific practices are as follows:

1. Only leave feces on the surface in low use areas, well away from trails, campsites and both perennial and seasonal water bodies. Choose a dry, open exposure that is unlikely to be walked over. Scattering and smearing the feces around will maximize exposure to the sunlight. Surface disposal is most desirable above timberline where digging holes or moving rocks can cause long-lasting impact.

2. In most situations, catholes are the preferred method of disposal. Choose a level spot and dig a hole, about 6 inches deep, in the organic soil horizon, where organisms are most abundant. Avoid wet areas and go at least 200 feet from trails, campsites and water bodies.
3. Latrines may be necessary for long stays by large groups in popular areas. Locate the latrine away from trails, camps and water bodies, on a well-drained forested site with thick organic horizons. Build it when you first arrive in camp and make sure that everyone knows where it is. Latrines should be at least 12 inches deep to minimize the chance that they will be dug up by animals or exposed by other people. After each usage, feces should be covered with soil and compressed with foot or shovel. This encourages decomposition. Fill in the latrine once it gets within about 4 inches of being full.
4. Minimize the use of toilet paper. If it is used, either pack it out (ideally) or bum it as completely as possible and bury any remnants. Do not burn toilet paper if fire hazard is high or if regulations prohibit it. Tampons should be packed out (unless you are in grizzly bear country) or burned in a very hot fire; they should never be buried.
5. It is best to urinate away from trails, campsites and water bodies. Areas with thick organic horizons and bare rock are the best sites.
6. Soap must not enter lakes or streams, so it is best to minimize its use. If bathing with soap is necessary, get wet; lather up on shore far from water, and rinse off far from water bodies with water carried in a pot. This procedure allows the biodegradable soap to break down and filter through the soil before reaching any body of water. Clothes can be cleaned by thorough rinsing. Soap is not necessary and residual soap can cause skin irritation. Avoid even rinsing in small water bodies.

E. WASTE DISPOSAL

The basic rule of waste disposal is to pack out what cannot be avoided by careful meal planning. Only waste water and fish viscera should be scattered and burning of waste should be minimized. Scattering of food remnants will attract wildlife and can alter feeding habits, migration patterns and reproduction levels. Although these effects are unlikely to be serious in remote places, it is always best to pack out scraps. Burial is ineffective because animals will dig up waste.

Specific practices are as follows:

1. Waste water, from washing dishes or excess cooking water, should be drained off either in the corner of a fire pit or away from water bodies and campsites (to prevent attracting flies). If there are large quantities of water, pour it into a sump hole or disperse it widely. Pick up food scraps and pack them out with excess food and other litter.
2. Litter and food scraps can be minimized with careful preparation. Food can be packaged in plastic bags, instead of cans, bottles or tin foil. Food can be carefully measured, so leftovers are minimized. When food is left, it should be packaged up and either eaten later or packed out. Partial burning, which is likely to occur when food is burned at the end of a meal, is unacceptable.
3. Fish viscera are generally a natural part of the ecosystem. They should be scattered widely, out of sight and away from campsites. In high use areas and in bear country they should be scattered a long way from camps. Do not throw viscera back into lakes and streams (unless bear danger is high and viscera can be thrown into deep water); the cool temperatures in most mountain waters prevent rapid decomposition.

APPENDIX D: NOLS REGIONAL GUIDELINES

1. DESERT CONSERVATION PRACTICES

Many desert environments appear largely sterile and lifeless, but this is deceiving. Most desert landscapes consist of dispersed islands of life and fertility in a matrix of largely barren rock and mineral soil. These fertile islands of vegetation, animals, decaying organic matter and structured soils develop beneath shrub and tree clumps. Although they may occupy only 10-20% of the ground surface, over centuries they become as structured, fertile and diverse as many humid environments. When these islands of vegetation and soil are disturbed, the results of centuries of biological cycling are destroyed and centuries will pass before recovery is complete.

Plant growth in deserts is limited by short supplies of water, a deficiency that is manifested in low resilience, the most unique characteristic of desert environments, relevant to conservation practices. Desert environments vary greatly in their ability to resist impact- some like cryptogamic soil are extremely fragile while others like sandy washes and slickrock are highly resistant; but all desert environments, except for those around water, recover very slowly once impact does occur. Because impacts are so long-lasting it is particularly important, in deserts, either to use an area in such a way that you leave no visual evidence of your visit (and do not disturb the fertile islands) or to use trails and campsites that are already highly impacted.

Riparian strips and areas around water holes contrast strikingly with other desert environments. In effect they are localized non-desert environments superimposed on the arid landscape. Riparian zones can often recover rapidly following disturbance; but their richer vegetation and soils can also be rapidly disturbed and these environments provide focal points for both wild animals and human visitors. Water is critical to the survival of wildlife and the enjoyment of visitors. Therefore, special attention must be paid to avoiding pollution of water sources and disturbance of the flora and fauna that depend on them, particularly where they are sparse.

Where water sources are sparse, social impact problems are aggravated by the tendency for all parties in any area to be attracted to and camp near the same water supply. Thus crowding problems can be unusually pronounced in desert environments.

Low resilience is one manifestation of the low productivity of deserts that results from a limited amount of water. Another manifestation is a slow rate of wood production. Therefore downed wood used for firewood is replaced very slowly. This makes deserts the least appropriate environment for fires, along with high altitude and high latitude environments.

Most desert environments can be used with relatively little impact, because resistant sites are usually abundant. The keys to low-impact are (1) to either confine activities to resistant surfaces or, where this is not possible or use is heavy, to travel on existing trails and camp on high impact sites, (2) to avoid disturbance of areas around water and not camp near water where supplies are scarce, and (3) to minimize use of wood for fires.

Backcountry travel

Practices are the same as the general practices, but several are particularly important and some of the details are unique to deserts. Because any scars you leave will be slow to heal, you accept a more profound responsibility when you choose to travel cross-country. Only travel cross-country where there are no established trails, there are durable routes on slickrock, along dry washes, or on non-vegetated ground (without cryptogam crusts, and you can be sure you will leave no evidence of your passage to attract others.

Cryptogam crusts are a particular concern. These crusts consist of free-living blue-green algae, fungi, lichens and mosses in a matrix of soil, that form conspicuous black pedestaled surfaces. These crusts have many functions. They increase soil stability, reducing the potential for both wind and water erosion; they increase the ability of soils to absorb rainfall and promote water conservation; they fix nitrogen and act as a nutrient reservoir for higher plants;

and they provide a preferred substrate for the germination and growth of plants. Unfortunately, just a few people walking across a crust will destroy the crust and leave a trail that will attract others. In cryptogam areas, stay on established trails or, if there is no alternative, have everyone follow in the same footprints and leave the area as soon as possible. (Note that having everyone follow in the same footsteps off established trails is the opposite of the general practice of spreading out when traveling cross-country-a practice that should be adhered to when crossing less fragile desert terrain).

Campsite selection and use

Practices are similar to the general practices. But particular responsibility is accepted when a pristine site is camped on, because any damage you cause will be there for a long time. With care, however, substantial impact can be avoided because there are many highly resistant environments in the desert (slickrock, dry washes, beaches, and even open ground between shrubs, if there is no cryptogamic crust). On all but the most resistant pristine sites, err on the side of caution by keeping group size down, keeping stays short and dispersing activities widely. Select a high impact site in popular areas and where you cannot be certain that you can leave a site with no evidence of your stay.

Avoid camping next to water unless you are in an area where water is abundant. This will minimize encounters with other parties that are drawn to the water source. More importantly, it will allow wary wildlife access to the water they need to survive and avoid harassment of the many animals that live in the rich environment the water supports. Camping close to water is probably more appealing in the desert than in any other environment, but this is where it is most critical to forego that luxury.

Fires and stoves

Practices are similar to the general practices. However, one quality of deserts makes fires particularly harmful there, while another provides opportunities to minimize fire impacts. The low productivity of deserts is reflected in slow replacement of wood burned in fires. Consequently, fires should be avoided except where there is an oft-replenished supply of driftwood (driftwood supplies are not replenished on many dam-controlled rivers) or where use levels are low. Even under these conditions fire should be minimized.

The prevalence of mineral soil makes it relatively simple to build a fire in such a way that you leave little trace when you leave. The very best sites are in the unconsolidated sands of a dry wash, where floods will eventually remove any evidence you do leave.

Sanitation

Practices are identical to those in the general practices. If you ignore the advice not to camp near scarce water sources, it is important to disperse widely and far from the water before depositing human waste in a cat-hole. Otherwise you may pollute the water supply and, in popular areas, risk either contracting or spreading diseases, due to excessive deposition of feces within a small area.

Waste disposal

Practices are identical to those in the general practices. If you ignore the advice not to camp near scarce water sources, extreme caution must be taken not to pollute water supplies with soap or other wastes.

2. HIGH ALTITUDE AND HIGH LATITUDE CONSERVATION PRACTICES

The common denominator of high altitude and high latitude environments is their low mean annual temperature and short, cool growing season. This confines growth to short and prostrate plants and limits productivity severely. Most plants adapt to these conditions by having most of their biomass underground. Consequently, there are many places where aboveground vegetation is sparse and mineral soil, rock and snow is abundant. Although annual productivity is low, places long-free from disturbance may be covered with luxuriant vegetation and may have well-developed soils rich in organic matter-vegetation and soil that has developed over centuries. Environmental heterogeneity, particularly in high altitude environments, is extremely high.

This greater heterogeneity at high altitudes is one of the primary differences between arctic and alpine environments. Alpine environments, depending upon local topography, can have longer and warmer growing seasons or they can be colder and less predictable than the arctic; there frequently is more late-lying snow. Another difference is the prevalence and importance of permafrost in many arctic landscapes.

The most unique characteristic of both of these environments is their low productivity, which makes recovery following disturbance extremely slow. Low resilience, along with a lack of firewood, makes these environments similar, as far as backcountry low-impact use is concerned, to deserts. Special caution must be taken to not disturb places that have not already been disturbed and fires should not be built except in emergencies.

Another similarity with deserts is the abundance of bare mineral soil, gravel and rock, particularly in alpine environments. This provides numerous resistant surfaces to use as routes when travelling cross-country or as pristine campsites. Also dense meadow turfs (tundra), with soil bound by the fibrous root masses of grasses and sedges, make quite resistant surfaces, as long as use levels are relatively low. Thus there are numerous means of minimizing impact as long as use levels are not high. Where use levels are high, however, it is important to stick to established trails and campsites, because resilience is so low.

A primary concern in arctic areas is to avoid heavy use of areas with permafrost with a high ice content. Loss of vegetation in such places will cause "thermokarst"-melting of the upper part of the permafrost, followed by subsidence and erosion of the soil. Loss of soil is catastrophic; we do not know how long it takes to replace an arctic soil but it must certainly be calculated in terms of thousands or tens of thousands of years. Try to confine travel to coarse-grained soils or bedrock and follow ridgetops or streambeds, avoiding wet areas with organic soils that are common in lower-lying areas.

Another feature to take advantage of are the many environments that experience frequent natural disturbance. Examples include large, braided glacial streams, caribou trails and slopes subject to solifluction. Any disturbance of such places will be removed in time by natural disturbances.

The "fragility" of high altitude and latitude environments, as with deserts, is more in how long scars last than in their ability to resist scarring. However, in some situations disturbance can be rapid and catastrophic, such as where lichen mats are destroyed or thermokarsting occurs. The keys to low-impact are (1) to either confine activities to resistant surfaces or, where this is not possible or use is heavy, to travel on existing trails and camp on high impact sites and (2) to minimize use of wood for fires.

Backcountry travel

Practices are not different from general practices, but it is particularly important to travel on established trails, except where use levels are low and you can be certain that you will leave no trace of your passage. Leaving no trace is not difficult where there is abundant bedrock, ice and snow. Meadow turfs and open tundra are also durable surfaces, although here you should spread out. In arctic tundra, the openness of vegetation and terrain makes it a simple matter to spread out and the prevalence of caribou trails provides numerous routes that have already been naturally disturbed. However, where soils are water-saturated or easily-displaced, particularly on steep slopes, or where vegetation is fragile, as in heath communities, you will leave evidence of your passage and, if enough other people follow in your footsteps, new and unwanted trails will develop. These are particularly unsightly at high altitudes and latitudes, where visibility is so high. Traveling in small groups and avoiding places where previous use is evident is important.

When following established trails, it is particularly important not to contribute to the development of braided or ever-widening trails. This is a common problem in these environments where trails cross mud holes or late-lying snowbanks, situations that can be widespread during early season (a good reason to avoid travel at this time). Stay in the trail tread and cross snowbanks directly or walk far from the trail, preferably on a hard surface.

Finally, because visibility is so great, it is particularly important to minimize your effect on other parties by avoiding brightly-colored equipment.

Campsite selection and use

As with backcountry travel, practices are not different from general practices, but the consequences of inappropriate behavior are particularly serious because impacts are so visually obtrusive and long-lasting. More responsibility must be accepted when not camping on a site that has already been highly impacted. This means selection of a resistant, undisturbed site, small groups, dispersal of activities, short stays, minimal disturbance of the site and camouflaging of any impact you do cause. The most resistant surfaces are on snow, ice, rock, gravel or unconsolidated mineral soil, such as along arctic rivers with large fluctuations in volume. If you must use vegetated surfaces, thick turfs of grass and sedge are quite resistant, while krummholz (prostrate trees near timberline), lichen-rich and heather communities are very fragile. Another recommended location is on small level areas below active solifluction lobes. Because these lobes are moving slowly downhill, they will eventually override the campsite and eliminate all traces of human disturbance. A common situation at high latitudes is to set up tents on dry tundra and a cooking area close by in a gravelly stream bed. Impact should be minimal as long as care is taken to avoid the creation of trails between tent and cooking areas. This can be a particular problem where the area between tent and cooking areas is steep and wet. It is always important not to move rocks and stones to create level campsites or build windscreens. Often vegetation can only get established in the protection of rocks, so their disturbance creates a permanent barren feature.

When using an established camp, it is particularly important to camp out-of-sight, due to the visual impact of other groups in the open landscape, and to avoid enlargement of the site and proliferation of user-built trails in the area.

Fires and stoves

Always use stoves at or above timberline, except in emergency situations, even where occasional patches of trees occur. Wood production is too low to support fires and the visual impact of fire scars is particularly pronounced in these open landscapes. The only exception is on streamside gravel bars in places where wood is relatively abundant and use levels are low.

Sanitation

Practices are similar to general practices, although this is the environment where surface disposal is most appropriate and group latrines are least appropriate. Soil and vegetation disturbance resulting from excavation of cat-holes will not recover rapidly and buried feces will decompose very slowly in the cold and sterile soil. These problems can be avoided if feces is deposited on the surface. Decomposition will be most rapid if the deposition site is in direct sunlight and exposure is increased by smearing the feces. However, surface disposal is only appropriate where there is no chance that other people will encounter it. This means it is important to seek out dispersed and isolated spots. It also provides an impetus to visit little-used places, when you are prepared to accept the responsibilities associated with off-trail hiking and camping.

In more popular places there is just no alternative to the use of cat-holes. Group latrines should be avoided at all costs, however, because such a concentration of waste simply will not decompose. It will be dug up by animals. This does not apply to existing latrines, which should always be used if available.

An option on glaciers is to make a latrine next to a deep crevasse, preferably one with relatively straight sides. With a shovel, feces can then be tossed to the bottom of the crevasse.

Waste disposal

Practices are similar to general practices, except that sump holes should never be excavated. Either use a naturally-occurring hole or disperse waste water widely.

3. CONSERVATION PRACTICES ON SNOW AND ICE

The presence of a thick mantle of snow or ice on the ground both offers unique opportunities for minimizing impact and presents unique challenges. The difficulties and hazards of cold place particular stresses on both wildlife and human visitors. Without special care this can result in serious impact that might not occur during warmer seasons or in less extreme environments.

A thick cover of snow shelters vegetation and soil from the normally inevitable impacts of trampling. Ice is also only ephemerally affected by trampling. Since trampling impacts are often the most serious unavoidable results of backcountry use, impacts caused by travel on snow or ice can quite easily be less pronounced than those at other seasons. However, as the snow mantle thins (either in early or late winter or in places where snow cover is less continuous), or as you leave the edge of an ice mass, the vulnerability of vegetation and soil increases to the point where they are much more easily disturbed than under snow-free summer conditions. This results primarily from the fragility of soils saturated with snow-melt waters. Such soils can become highly compacted and muddy and they are often easily displaced. Plants pressed into muddy soils have little chance of survival and plants growing in wet coarse soils are easily uprooted; plants can also be particularly vulnerable if they become brittle in fall or if they are just beginning to translocate nutrients from underground perennial tissues to aerial growing points in spring.

Probably the most important aspect of low-impact winter use is the need to minimize disturbance of wildlife. (This is less of a concern during travel on ice in other seasons.) Like humans, wildlife find winter a particularly challenging and stressful season. Unlike humans they do not have sleeping bags and tents to conserve heat and energy and they cannot bring their own food, they must scrounge for it under deep snow or in windswept areas. Finally, the large animals cannot travel on top of the snow, as humans do; they must plow through the snow, utilizing tremendous stores of energy when they must travel long distances. Given these problems, the most common winter strategy is to conserve energy by lowering activity levels-not moving rapidly or great distances unless absolutely necessary. Plight from recreationists and even an increased heartbeat associated with fright defeat this survival strategy. Energy consumption increases, so more food is required; but more energy is needed to seek out food and if food is scarce or there are large numbers of competing animals, some animals may not survive or the stress they undergo may reduce their reproductive capacity. Therefore it is critical in winter to stay far enough from wildlife to not induce flight or even cause fear.

Another unique characteristic of winter is that downed wood is covered by snow. Along with the difficulty of disguising fire remnants in winter, this makes fire a poor choice in winter.

Finally, proper disposal of human waste is extremely difficult, because it can be hard to dig down through the snow to the soil or to dig a cat-hole in frozen soil. This is probably the most difficult aspect of low-impact winter use. In popular areas for either summer or winter use, few acceptable solutions are available. Roper disposal on ice is even more problematic.

Backcountry travel

The primary concern with travel is minimizing impacts on wildlife. As long as the snow is deep, impact to vegetation and soil is minimal and except in a very few places use levels are so low that there need be little concern for other visitors. Consequently, many of the general guidelines can be relaxed. Bright clothes are more acceptable and can be desirable from a safety standpoint. Large groups are more acceptable and can be desirable from a wildlife impact perspective. Limited research suggests that frequent encounters with small groups are more disturbing than infrequent encounters with large groups. So it is probably best to keep groups close together and avoid dispersal of people or smaller groups in places that wildlife use for refuge. There is also little reason to be concerned about where you travel (other than to avoid wildlife disturbance). Crosscountry and trail travel are equally acceptable and there is no need to worry about resistance of the ground. Perhaps the major

consideration, beyond wildlife, is that visiting places that are infrequently used during any season will make disposal of human waste and even having fires less problematic. In contrast to travel on solid ground, which is often quite fragile, dispersal of use and visitation of little-used places is always preferred on snow and ice.

On popular mountaineering routes, concern for minimizing your impact on other parties is required. Party sizes should be smaller and travel at less popular times is encouraged.

Campsite selection and use

As with the travel guidelines, the lack of trampling impact to soil and vegetation permits many guidelines to be relaxed. The most important considerations are to select a site where you will not disturb wildlife or pollute water supplies and where you can dispose of human waste properly. This can be accomplished by camping well away from trails and bodies of water—both those that are open in winter and those that will be running in spring or summer, as well as places that wildlife frequent.

There need be little concern for whether the site selected is pristine or highly impacted, for the resistance of the ground, for whether you concentrate or disperse tent sites and traffic routes, for size of the group or for length of stay—as long as wildlife is not disturbed and human waste can be disposed of properly.

There is some controversy about whether or not snow structures you build should be left standing. Although leaving them can provide comfort and even safety for you or others, this practice provides an unnecessary reminder that others have been here before and negates the principle of leaving pristine areas as they were found. Therefore, we suggest that such structures be removed unless there is a high likelihood that you will return on the same trip and you are in an area that is infrequently visited in winter.

Fires and stoves

There are several compelling reasons for not building fires in winter. Dead and downed wood that is dry is essentially non-existent, so the temptation will be to tear off lower branches or mutilate standing snags. Moreover, it is extremely difficult to properly dispose of the remains of a fire built in snow. Therefore, fires are not recommended except in an emergency. However, in remote areas that are seldom used during any season occasional small fires are acceptable, if care is taken to not disfigure trees when collecting firewood and some attempt is made to disperse charcoal and ash.

Sanitation

Practices are similar to those in the general practices, but it can be difficult to use the cathole technique properly. Given this difficulty, it is best to travel and camp in places that are seldom visited in summer. In such places, human waste can be deposited on the snow or ice in an out-of-the-way place, far from drainages. Decomposition will not occur after the feces is covered with snow and snowmelt waters will probably spread any pathogens, so it is critical that your disposal site is far from water (so it can break up and disperse) and in a place where human contact is unlikely. If you can dig a cathole in the ground, however, that is preferable.

In popular areas, the only solution is to try to emulate summer practices and make the effort to use catholes. If it is too difficult for everyone to dig their own personal holes, it may be necessary to construct a group latrine.

When travelling on glaciers, human waste can be deposited in crevasses. Although we do not know much about this practice, it is probable that feces will be ground up and pathogens will be dispersed before significant contamination occurs. As always, concentration of large quantities of waste in one area, particularly if it is frequently used by others, demands particular caution and should be avoided, if possible.

Kick snow over urination holes, unless in conditions (heavy current snowfall or no other winter users) where they will not be seen.

Waste disposal

Most practices are similar to the general practices. Waste water should be concentrated in one or a few holes and covered with snow when camp is broken. Extra care must be taken not to litter since it is so easy to lose items in the snow. Give special attention to plastic bags and wrappers and to candle wax. Candle wax should be caught in a cup and packed out.

4. COASTLINE CONSERVATION PRACTICES

The most unique and common characteristics of coastlines are the intertidal zone, the area between low and high tides that is strongly affected by incoming seas twice a day, and sporadic higher beach deposits that often extend inland for short distances, having been deposited by major storms or transported by winds. The intertidal zone can be either quite fragile (e.g. rocky tidepools that support an abundant flora and fauna) or extremely resistant (e.g. cobble, gravel or sand beaches). Intertidal and higher beach deposits are usually resistant because they consist almost entirely of unconsolidated mineral soil. Vegetation, organic matter and soil development are minimal; consequently there is little for human use to disturb. However, where vegetation has become established and, particularly, where embryonic dunes are forming, human impact can be significant. Loss of vegetation can cause accelerated wind erosion, greatly altering the morphology of the beach and, particularly, sand dunes.

In the intertidal zone, much of the evidence of human disturbance is removed by incoming tides twice a day and some inland areas are "cleansed" after major storms. Therefore, these resistant environments are also highly resilient. Most impacts that do occur are removed, depending upon their location, either daily or yearly. There are exceptions, however. Impacts beyond the zone disturbed by tides and major storms are similar to those that occur elsewhere. And, as mentioned earlier, certain environments within the intertidal zone and higher beaches are quite fragile and subject to long-term disturbance. Because much of the coast is particularly resistant and resilient, while some places are quite fragile, it is particularly important to concentrate activities on resistant beaches and particularly where tides or storms will cover evidence of human use.

The vast quantity of water in the ocean, along with the transporting effects of tides and currents, also provides a unique opportunity for dispersion and dilution of certain waste products that cannot be disposed of properly (other than to carry them out) in other environments. Most wastes that are not carried out are better deposited in the ocean than on land. However, because the abundant flora and fauna of tidepools are inundated by ocean waters, it is critical that concentrated dosages of pollutants are kept away from tidepools and camping areas.

Although the relative abundance of resistant and resilient substrates and the ease of dispersing certain wastes in the ocean make coastlines relatively durable environments, certain problems are aggravated by the fact that use is concentrated along a narrow coastal strip. On popular routes, certain campsites are used over and over again and often by quite large groups. This contributes to localized problems with human waste disposal and trampling impacts beyond the beaches and intertidal zone, where vegetation and soils are better developed.

Generally, coastal zones should be the easiest environment for the recreationist to use responsibly. The overall keys to low-impact use of coastlines are to (1) concentrate activities on resistant substrates just above and below high tide lines, (2) avoid damage to tidepools and disturbance of wildlife, and (3) minimize sanitation problems by choosing less popular campsites, disposing of human waste in the ocean where possible and dispersing human waste widely on land where this is not possible.

Backcountry travel

Practices are the same as for the general practices, although some are particularly important here and some of the details are unique to coastlines. Because impacts to trails are minimal and campsite damage is limited by the resistance of available substrates, particular attention can be paid to minimizing

impact on other groups. Thus it is particularly worthwhile to travel during lightly used days and seasons and to select lightly used routes where this is possible.

The abundance of wildlife and edible foods should not lead to complacency. Wildlife disturbance should be avoided; give nesting birds and marine mammals a wide berth and take particular care not to damage tidepools. The eggs and young (up to 4-6 weeks) of brown pelican are vulnerable to predation, particularly by gulls and ravens, when your intrusion scares adults off nests. Gulls have even been known to follow humans and then eat eggs or young when adults flee. So be careful to avoid disturbing pelicans during nesting season. Disturbance of ospreys should also be minimized during nesting season. Edible foods, particularly shellfish, should not be overharvested. This may mean only harvesting in places that are not frequently visited. Finally, when spearfishing, take care to minimize the chance of maiming fish.

Campsite selection and use

Most practices are the same as for the general practices. The major difference is that use of relatively undisturbed sites is particularly appropriate on coastlines, even where use is heavy. This follows from the fact that sand, gravel and cobble beach substrates without soil development or vegetation are so abundant. These environments are little disturbed by use and evidence of use is usually removed quickly by high tides or large storms. They can be used repeatedly and for long periods, even by large groups, with little adverse impact.

Where resistant beach substrates are abundant there should be no need to choose a high impact site, regardless of how popular an area is. Merely select a resistant site on sand, gravel or cobbles for kitchen and sleeping areas. There is also no need to worry about either concentrating or dispersing tent sites or traffic routes as long as activities are confined to resistant substrates.

Where beach deposits are scarce or small, however, more care is needed. If beaches are small, confine as many activities as possible, including those associated with the kitchen, to the beach and set up sleeping areas further inland. When it is necessary to camp off the beach, follow the general guidelines for campsite selection and use and, in Baja California, the modifications for desert environments. There, dry washes are preferable locations to higher ground with more vegetation and better developed soils and high impact sites should be used in popular areas. Avoid creating trail systems between tent and kitchen areas.

Fires and stoves

Practices are the same as for the general practices. As with campsite impacts, it is particularly easy to leave essentially no trace of fire impacts if fires are built on beaches below the high tide line. Such a fire is built on unconsolidated mineral soil where it will have little effect. Once all wood and charcoal is burned down to ash, ashes and rocks are thrown into the ocean, and excess firewood is scattered on land, the high tide will eliminate residual evidence of the fire.

If fires cannot be built on the beach, below the high tide, the need for a fire should be carefully evaluated. If necessary follow the general guidelines for fires and stoves and, in Baja California, the modifications for deserts.

The presence of driftwood makes firewood often-but not always-particularly abundant. Driftwood, particularly what has been milled or otherwise altered by humans, should be collected before using wood from further inland. Again, carefully consider the need for a fire if there is little driftwood or if use is sufficiently high to seriously deplete existing driftwood supplies.

Sanitation

The major difference from general practices is addition of the possibility of urinating and depositing feces directly in the ocean. It is a simple matter to urinate below the high tide line-away from the tide pool areas-where the ocean will quickly dilute the urine. Away from campsites, feces can be deposited on a rock and hurled into the ocean. Shells and flat rocks are abundant alternatives to toilet paper. An untried technique with considerable potential, particularly when using popular campsites, is to line an ammo box with paper (it must be biodegradable), have all party members deposit their feces in the lined ammo box and then deposit the paper and feces in the deep ocean on the next travel day. Where neither of these options are feasible follow the general guidelines for sanitation.

Waste disposal

The major difference from general practices is that certain wastes can be deposited directly in the ocean with little adverse effect. Fish viscera are generally a natural part of the ecosystem. Deposited below the high tide line-but away from camps-they will be scavenged by birds or eaten by fish. Away from popular campsites, it is probably less harmful to use biodegradable soaps directly in the ocean than to pour it onto the land-although this is a poor practice where large groups repeatedly use the same site or in areas of rich tidepool life. It is always best to minimize use of soaps and not deposit sizeable quantities in any single place.

Finally, in Baja California, cans can be deposited in the deep ocean after paper has been removed and the ends have been cut off. While such littering appears to run counter to the wildland ethic, the alternative in Baja is frequently that garbage is dumped alongside roads in the desert, an environment much less capable of degrading cans than the ocean deeps. This practice is not generally recommended in places where litter that is packed out is likely to end up in a legitimate garbage dump.


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â€™ The human role in [ecosystems](#) differs from that of any other [species](#) in two ways. First, humans have the ability to drastically alter the ecosystems upon which they depend; secondly, humans are capable of greatly reducing or eliminating many of the factors that formerly limited their numbers. These capabilities can result in an intolerable pressure on natural resources and life support systems.

â€™ For development to be ecologically sustainable, its benefits must continue to be maintained indefinitely. The principle of [sustainability](#) must be widely applied if Canadians as well as people in other countries are to enjoy an acceptable quality of life in the future.

â€™ Environmental protection cannot be successfully accomplished in isolation from social and economic development. Regular [monitoring](#) and evaluation of all development activities and policies are essential to the achievement of sustainability.

Sustainable development deals with interrelationships and linkages. It means looking at decisions in a holistic way where there is a parallel care and respect for people and for the enveloping ecosystem of which everyone is a part.

â€™ Hodge et al. (1995)

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A Holistic View of People and the Environment

[What is an ecosystem?](#)

[Human alteration of ecosystems](#)

[An ecosystem approach](#)

[People as part of ecosystems](#)

In the past, the [environment](#) was usually thought of as being external to our lives, as something "out there": a pool of resources to provide us with food, clothing, and shelter. We used the environment's resources to benefit humankind, and the success of that exploitation was often taken as a measure of progress. Throughout the world, resources â€™ land, water, fish, trees, and animals â€™ were managed and used in isolation. Now, it is increasingly apparent that, one way or another, all of these things are interconnected. The use of one environmental resource always has some immediate or long-term impact on the status of another resource or ecosystem.

Moreover, having once looked at the natural [environment](#) as something apart from ourselves, to be exploited or overcome, we now see ourselves much more as an integral part of it. We are part of an interactive global [ecosystem](#) â€™the ecosphere. Success in maintaining the quality and productivity of our environment will depend on acknowledging this relationship and acting accordingly.

The world's population has multiplied almost fivefold since the early 1900s. During the same period, the world's economy has grown by 20 times, the consumption of [fossil fuels](#) by 30 times, and industrial production by 50 times. The World Commission on Environment and Development (1987) has forecast that world industrial activity could multiply by an additional 5â€™10 times, given that many countries have yet to complete the industrialization process.

Such figures hint of profound impacts upon the ecosphere, as the world's people continue to invest in houses, transportation, and industries. Ecosystems have finite productive capacities and abilities to assimilate disturbance. The potential for [disturbance](#) becomes magnified as the population grows, resulting in greater demands being placed on energy supply and on [ecosystems](#). To come to grips with this situation, the global community has advocated that a holistic approach be followed, whereby environmental, social, and economic systems are collectively considered throughout decision-making processes (IUCN et al. 1980, 1991; UNCED 1992). The [conservation](#) of basic life support systems, the long-term [sustainability](#) of [species](#) and resources, and the acknowledgement of fundamental relationships between people and the [environment](#) are key elements in this approach.

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Agriculture

â€™ Some agricultural lands remain at high risk of degradation from wind and [water erosion](#), salinization, [soil compaction](#), and [organic matter](#) loss. In addition, the protection of water quality has emerged as one of the key environmental challenges facing agriculture in the 1990s. Nitrate is found in virtually all [groundwaters](#) in the agricultural regions of the country; levels are usually below recommended safe limits, but areas of intensive agriculture and areas under heavy manure application or irrigation are prone to levels above safe limits. Other agricultural contaminants, such as [pesticides](#) and bacteria, have also been detected in certain areas.

â€™ Considerable progress has been made in ensuring long-term [sustainability](#) of [agroecosystems](#) through the increased use of sustainable land management practices. For example, in 1991, conservation tillage (including no-till) was used on about one-third of Canada's cultivated land, compared with minimal use 10 years earlier; there was a 27% reduction in [summerfallow](#) between 1971 and 1991; and changes in cropping and tilling practices resulted in a 7% decrease in the risk of [wind erosion](#) in the Prairie provinces between 1981 and 1991 and a decrease of 11% in the risk of water erosion in Canada during the same period. Initiatives aimed at minimizing water [pollution](#) include improving manure storage and management and more selective application of pesticides and fertilizers.

Forestry

â€™ Nationally, area harvested is minimal compared with area affected by natural [disturbances](#). Regionally, however, harvesting may be a major agent of disturbance. [Clear-cutting](#), while controversial, remains, by far, the preferred harvest method of industry. The harvest of old growth continues to be an issue of major regional significance.

â€™ Positive trends include greater efforts to regenerate trees removed by harvesting (between 1975 and 1993, the area harvested increased by 42%, whereas the area planted or seeded increased by 228%); reduced [pollution](#) from pulp and paper mills (almost all are meeting current [effluent](#) standards); increased use of recycled material for pulp and paper production (the amount has tripled since 1980); and large declines in the use of chemical [pesticides](#) â€™ a trend that is expected to continue with increasing use of biological insecticides.

Fisheries

â€™ Many [groundfish](#) stocks in the northwest Atlantic and some salmon

stocks on the Pacific coast have been overharvested. Some fisheries have been closed on the Atlantic coast. Overharvesting, inappropriate fishing practices, changes in environmental conditions, and changes in predator and prey abundance all contributed to the severe decline in stocks. The ability to harvest some marine resources (excessive amounts of labour and capital in the industry) exceeds sustainable levels. Assessment, [monitoring](#), and [conservation](#) of fishery resources need strengthening.

â€¢ Many initiatives are contributing to more sustainable fisheries for the future. For example, new management approaches include taking a "fish first" view to managing the fishery; setting cautious harvest levels; a larger role for the harvesting industry; increased industryâ€‘government partnerships to improve information on stock status and reduce harvesting to sustainable levels; a transition to a truly multispecies approach; the introduction of individual quotas; and reduction of fishing capacity and workforce.

Minerals, metals, and mining

â€¢ There are a number of environmental concerns related to the mining, smelting, and refining of minerals and metals. Acidic drainage is the largest environmental problem facing the global metal mining industry. In Canada, there are an estimated 12 500 ha of acid-producing [tailings](#) and 739 million tonnes of acid-generating [waste rock](#). Smelting and some refining take place in furnaces at high temperatures. Emissions from these furnaces include sulphur dioxide, [particulate](#) matter, and [heavy metals](#). The largest emission source of sulphur dioxide in Canada is the smelting of metal concentrates, which contributed 50% of total eastern Canadian sulphur dioxide emissions in 1994. Post-operational waste management is a major long-term issue because of high costs, the number of sites, and the limited number of technical options.

â€¢ Canada has a significant [recycling](#) industry. During 1994, Canadian trade in [recyclable](#) metals exceeded 4 million tonnes, valued at over \$2 billion. By reducing demand for "new" metals, recycling has significant environmental benefits, including reduced discharges to water and air, reduced [habitat](#) disruption, and overall energy savings. There have been substantial reductions in quantities of sulphur dioxide released from eastern Canadian smelters and refineries owing to a combination of equipment installation and changes in metallurgical processes since the 1980s. In recent years, various multistakeholder cooperative programs have been launched to further reduce the environmental impacts of mining. The Whitehorse Mining Initiative, the Assessment of the Aquatic Effects of Mining in Canada process, the Aquatic Effects Technology Evaluation program, the Mine Environment Neutral Drainage program, and the Accelerated Reduction/Elimination of Toxics program indicate that it is in the best interests of all concerned to work together to develop and implement sound environmental policies and practices to ensure [sustainable development](#).

Energy use

â€¢ Energy production and use are leading sources of atmospheric pollutants that contribute to [climate change](#), [acidic deposition](#), and [urban smog](#). About 90% of Canada's human-produced emissions of [carbon dioxide](#) arise from energy usage, with [fossil fuel](#) use accounting for 98% of this total in 1992. Without further action, carbon dioxide emissions are expected to increase by 10â€‘20% between 1990 and the year 2000. Energy-related sources also account for about 55% of sulphur dioxide emissions, 90% of nitrogen oxide emissions, 55% of volatile organic

compound emissions, and 35% of [methane](#) emissions. In addition, about 70% of the total carbon monoxide emissions in Canada are energy related.

Progress is being made in controlling [pollution](#) from energy systems. Under the Canadian Acid Rain Control Program, national targets for aggregate sulphur dioxide emissions were met ahead of schedule. In addition, a comprehensive management plan to control [nitrogen oxides](#) and [volatile organic compounds](#) was agreed to by the Canadian Council of Ministers of the Environment in 1990. Under the Framework Convention on Climate Change, Canada has committed to aim at stabilizing [greenhouse gas](#) emissions at 1990 levels by the year 2000. It is unclear at the moment whether Canada will be able to meet this objective. However, governments, industry, and other stakeholders are now working together to develop programs and measures that will facilitate meeting this goal.

Transportation

Innovation and regulation have resulted in impressive gains in [fuel](#) efficiency and emission control on a per vehicle-kilometre basis in Canada during the past 20 years. The average Canadian passenger vehicle (in-use fleet) improved 39% in energy use per kilometre travelled between 1974 and 1994. Similarly, the average new car in 1990 produced only 24% of the [nitrogen oxides](#), 4% of the [volatile organic compounds](#), and 4% of the carbon monoxide of a new car in the early 1970s. However, gains in energy efficiency and emission reductions per vehicle based on improved technology have slowed in recent years and are being offset by the fact that Canadians now own more vehicles per capita and, on average, drive them further annually.

Barring a fundamental breakthrough, technological innovation alone in transportation systems is insufficient to bring about lasting change towards more environmentally sustainable transportation in Canada. Significant changes by millions of Canadian households in the way they use the automobile and other transportation modes will be required. Many Canadian communities are pursuing a variety of initiatives to improve the [sustainability](#) of transportation, ranging from [urban](#) design and demand management to transit efficiency and education/outreach. However, many of these efforts are currently at the planning or testing stage, not the action or achieving stage. Transportation involves every member of society and all levels of government; hence, a high degree of cooperation is required to effect long-term, sustainable, and equitable results.

Manufacturing

Manufacturing is a significant contributor to atmospheric emissions. In 1990, 23% of total sulphur dioxide emissions, 21% of [particulate](#) emissions, 4% of total nitrogen oxide emissions, and 4% of volatile organic compound emissions were from manufacturing.

Depletion of the [stratospheric ozone](#) layer has been linked to the action of a number of manufactured chlorine and bromine compounds. Under the Montreal Protocol of 1987 and subsequent amendments, action by government, the scientific community, industry, and individuals has led to a decrease in new Canadian supplies of ozone-depleting substances, from 27.8 kt in 1987 to 5.7 kt in 1994.

Outdoor recreation and tourism

In 1992, Canadians took 97 million overnight trips, 55% of which were

to small city, town, rural, and wilderness destinations. Activity on this scale has substantial consequences for the [environment](#), particularly in terms of transportation-related impacts, resource consumption, and disruption of [wildlife habitat](#) and natural [ecosystems](#). Recreation and tourism have provided Canadians with considerable economic returns, which are well documented; their social and their environmental significance are not.

â€¢ Given the scarcity of data and analysis on the environmental effects of recreation and tourism in Canada, it is difficult to draw firm conclusions about their overall implications with respect to environmental [sustainability](#). Nevertheless, visitor/tourism facilities are a major source of ecological impact on specific areas such as parks. To deal with some of these impacts, governments and industry are developing management tools and strategies, including awareness program development, codes of ethics and conduct, and environmental impact and other studies.

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minimal impact means bushwalking softly



Minimal impact

Minimal impact (n). *Caring activities designed to decrease the negative effects that users have, especially on the environment.*

Minimal impact techniques are used to reduce the effects that people have on the environment. Minimal impact bushwalking (MIB) allows walkers to enjoy their natural surroundings without causing too much environmental degradation.

IT'S ALL ABOUT WALKING SOFTLY!



The use of fuel stoves

Campfires cause unsightly scars on the landscape. Burning and collecting wood can destroy homes for small plants and animals. Escaped campfires can lead to disastrous bushfires. For these reasons the entire World Heritage Area and some other areas in Tasmania have been declared Fuel Stove Only Areas, this means campfires are not permitted and fines apply. When using a fuel stove take care to place your stove and any hot pots on hard surfaces. Some vegetation does not easily recover from the heat of stoves and pots.



Pack it in – pack it out!

Take all of your rubbish out with you! Why? Littering spoils the experience for others. Most rubbish won't decompose and causes pollution. Animals may try to eat your rubbish; this can seriously harm them. Rubbish includes food scraps, twisty ties, sanitary pads and tampons, condoms, and any other bushwalkers' garbage you can collect off the track!



Stay on track

For your own safety and the environment's sake, please stick to the formed track. If the track is braided or wide stay in the middle of the track. If there is no track, fan out and do not follow in each other's footsteps. Never create a track with tape or cairns. This is illegal and fines apply.



Campsite etiquette

Pitch your tent on an established site rather than creating a new one. If raised tent platforms or huts exist please use them. Once camp is established minimise your movements. Collect your water once for the evening rather than making repeat trips. A large water carrier like an old wine bladder is great for this.



Phytophthora procedures

The root rot fungus *Phytophthora cinnamomi* is present in Tasmania. This microscopic fungus is transmitted in mud and soil and can kill native plants. To help stop the spread of Phytophthora make sure you start the walk with clean gear including boots, tent pegs, gaiters and tent floor. Make sure you use washdown stations when they are provided on track. At the end of your walk wash down all equipment.



Toilets in the bush

If a toilet exists please use it! If there is no toilet then walk 100m away from water and the track, dig a 15-cm hole and bury your waste and the toilet paper as well.



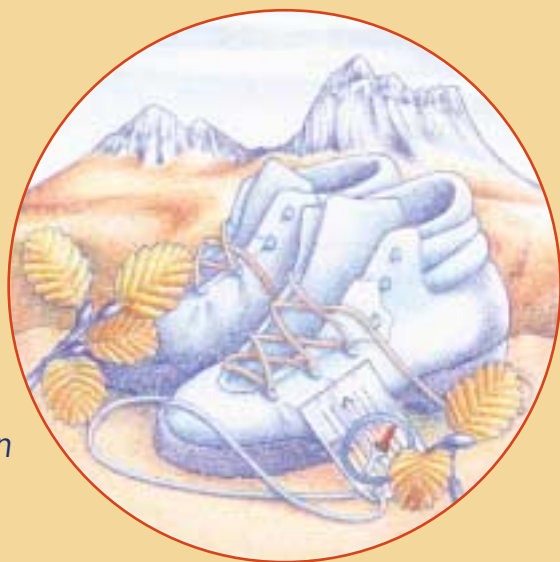
Party size

The Parks and Wildlife Service recommends varying party size restrictions for different walks. If you plan on walking in a group larger than 6 contact the Parks and Wildlife Service for further information.

For further information, questions and comments
contact the Parks and Wildlife Service
Ph: (03) 6233 2669 Fax: (03) 6223 8308
Email: tracks@dpiwe.tas.gov.au



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Illustrations: Kete Rowe Graphic design: Dixie Makro, e.g. design Photograph: Grant Dixon June 2000

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Camping Tips: Advice for Low Impact Campers

Learn these steps of low impact camping in order to preserve the wilderness areas. Ideas about keeping your trip simple.

Women Stand and Pee

Neatly pee while standing, without dropping your drawers!
pmateusa.com

Prepare for Camping

Get Info On What To Pack Before You Go Camping
RevolutionHealth.com

Camping

Find Camping Here. Visit our Camping Guide.
About-Camping.info

Bow Drill Kits

Designed to start campfires easily the old fashioned way.
ScoutSkills.com

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Every year avid fans of backpacking and camping take to the wilderness for the pure pleasure of connecting with the environment. What we do while on the trails makes a permanent impression on the wilderness areas we love. If we do not follow the steps of low impact camping our beloved wilderness areas will become no more than a roadside campground full of litter and leftovers from unconcerned campers.

Low Impact Camping is just that; low impact.

Low Impact is camping with the least amount of negative impact to the environment. By practicing these methods of low impact camping we can all be assured that our beloved wilderness areas will be there for future generations to enjoy just as we have.

First, keep your group small. The smaller the better because this means that your campsite will not be trampled down or over used. After you have selected the place your group will camp be sure to keep the campsite at least one hundred feet from the trail. Try also to use an area that is screened by natural [flora](#) and trees because this way you will be inconspicuous to others who will be moving along the same trail you have used.

What equipment you use is also important. Colorful camping gear may have caught your eye in the store but it really serves no purpose on the trail. Animals will see you before you see them and also colorful camping gear can and usually becomes offensive to others who are on the trail. Most have noticed while in the wilderness a campsite dotted with florescent tents invading the area. They are out of place and do not belong and are a great distraction to many including the [wildlife](#), so avoid them if you can.

Keep your improvements at your newly found campsite to a minimum. Do not dig trenches around the camping area. These trenches will lead to erosion over time. Hip Holes will cause the same type erosion and should not be used either.

Use a "Hard" Campsite.

A hard campsite is an area where solid terrain is found. Avoid any area that is less than two hundred feet from a water source. This ground is soft and cannot take the wear and tear of repeated use for camping. Also avoid meadows and dense forest areas. By using areas that include dense flora this causes the flora and mosses to become trampled and they can and will erode and die if overused. Be sure to set up camp in a stable area where the ground is stable such as on a granite slab or very firm and dry dirt.

Be sure to pack out all your refuse. Never leave your trash in any wilderness area. By leaving trash, not only is it unsightly to the next hiker, backpacker, or camper but it is dangerous to area wildlife. Keep in mind that even a twist tie from a bread bag can turn into a lethal substance for any animal to ingest.

Never litter any wilderness area, and if litter is present, pick it up and pack it out even if you did not leave it. We all must be responsible even if the last person to visit the area was not so responsible.


Large campfires are out. The big campfire became very passe' once environmentalists began to see the effects of such fires. In most areas wood is being used faster than it can reproduce which leads to depletion of the area timber. By gathering kindling you are making an impact on the environment because fallen kindling rots away leaving mulch for seedlings to sprout in. Your best bet is to use a propane stove for cooking and heating in your camping area. By doing this you are not only saving wood, but also saving a forest fire from happening.

Protect the waterways.

This is a very important step in environmentally sound camping. Never dig your latrine closer than two hundred feet to any waterway, even a small stream that appears to be mostly underground. Do all washing from the same distance. Avoid getting soap into the waterway system because not only is it a pollutant but animals drink from the same waterways that you are bathing in. This can cause much harm to wildlife since they have not been exposed to such chemicals like our own family pets have been. These wilderness animals possess a much more delicate system than the animals we have contact with on a daily basis.

When hiking back if your party should hike through a meadow or heavily laden flora area be sure to spread out. Do not play follow the leader in these areas. In theory we know that we should stay on the trail if at all possible but in a large meadow or field this creates erosion in one particular area which can lead to much bigger problems. This area could later recede further and also a large rut could develop which again causes the area to erode and kill delicate flora and unseen wildlife. Spread out and never follow the leader in these large areas.

Any time we visit the wilderness we should carefully follow these steps to ensure that these pristine areas will be with us for generations. Not only are we responsible for our generation but we must take care to undo damage from previous generations to ensure the future of wilderness areas for all.

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RECREATION

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Introduction

The Recreation Section of the State Forest Resource Management Plan is the means by which the recreation policy, goals and objectives are translated into operating guidelines. The operating guidelines coordinate the management and development of recreation opportunities on state forest lands.

The Pennsylvania State Constitution states, in Section 27, "The people have a right to clean air, pure water, and to the preservation of the natural, scenic, historic and esthetic values of the environment. Pennsylvania's public natural resources are the common property of all the people, including generations yet to come. As trustee of these resources, the Commonwealth shall conserve and maintain them for the benefit of all the people." The Commonwealth's obligation to conserve and maintain these resources for all people is foundational for the Bureau of Forestry. Further, the Conservation and Natural Resource Act of 1995, P.L. 89, No.18 authorizes the establishment and provides for the use and control of state forest lands. This law states, in part, that one of the purposes for which the state forests was created is "... to furnish opportunities for healthful recreation to the public."

Because of the size of the land base, state forests provide a unique opportunity for dispersed low-density outdoor recreation that cannot be obtained from small forest areas or from private ownership. However, state forests are finite and cannot provide everything to everyone. Recreational opportunities on state forest land will be aimed at those forms of dispersed forest recreation that are not being provided by other land uses or ownerships and that are compatible with the forest ecosystem.

Outdoor recreational pursuits are continually changing. Our social structure, affluence, mobility, leisure time and a multitude of new recreation equipment influence these changes. As opposed to basic human needs for forest products, recreation deals more with attitudes and emotions. The department has in the past and will continue to be aware of attitudes toward recreation and will strive to provide a healthful outdoor recreation experience.

Today there are many forest users who have views and activities that sometimes conflict. Some people seek the peace and solitude that forests provide in order to promote mental and physical fitness. Others enjoy more physical activities to achieve the same outcome. There are those who prefer traditional forms of recreation such as sight-seeing, hiking, hunting, fishing, horse-back riding, cross-country skiing and others who find state forests ideal places to ride ATVs, snowmobiles, mountain bikes, hang gliders, and dog sleds.

Increasing recreational use is having a greater impact on other resources and the forest ecosystems. With the influx of more individuals and groups in pursuit of their recreational activities, it becomes increasingly important for the bureau to develop management strategies to provide a quality outdoor experience, minimize conflicts and maintain ecological processes.

The recreation section consists of a history of state forest recreation, an inventory of current recreational opportunities, a statement of policy, goals and objectives, operating guidelines that regulate the coordinated management and future development of recreation, indicators of progress towards goals, and a list of critical research needs.

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History

The first purchase of state forest land was in 1898. The original intent of state forest land was to acquire and protect watersheds following the devastating logging practices and resulting fires of the late 1800's and early 1900's. Shortly after the first state forest land was acquired for conservation it became apparent that these lands were ideal places for outdoor recreation.

In 1900 Governor William A. Stoner declared that "forest reservations" were to be parks and outing grounds for people forever. In 1904 the first rules for the use of state forest land included camping rules and references to picnicking. Although Mont Alto, Caledonia, Promised Land, George W. Childs, James Buchanan and Pine Grove Furnace State Forest Parks were in existence when Governor Stoner made his declaration 1900, the first concerted effort to establish formal recreation areas on State Forest land did not begin until 1920. This is when Snyder-Middleswarth, Voneida (Now known as Hairy Johns Picnic Area) and Leonard Harrison State Forest Parks were developed. These early parks were developed on state forest land and the Bureau of Forestry was responsible for their management.

However, the main emphasis for these new lands was on fire control and reforestation. The top priority for these new lands was to develop access. Eventually people began to use these roads and trails for other purposes. Forest reservations soon became places for people to enjoy their recreational pursuits.

Hunting and fishing were the favored outdoor sports during this time. Many hunters and fishermen became so attached to their favorite hunting grounds that they needed places to stay for longer periods of time. On March 27, 1913 the legislature passed an act to legalize the leasing of permanent camp sites on state forest land. Thirty leases were developed in this first year. The number of leased camps increased to 2088 by 1929 and jumped to 3180 by 1935. The number of leases grew to 4500 when the program stopped allowing new leases in 1970.

In 1927 a Division of Parks was established within the Department of Forest and Waters to satisfy the demand for new recreational opportunities.

On March 31, 1933, President Franklin D. Roosevelt signed the Emergency Conservation Work Act. This was the legislation that created the Civilian Conservation Corps (CCC). The CCC was responsible for much of the infrastructure that is found on state forest land today. Many CCC projects resulted in improved access and were designed specifically to satisfy the public's recreational demands. Projects included the construction of roads, bridges, foot trails, horse trails, cabins and recreational impoundments. This program was de-authorized in 1942 in response to the U.S. involvement in World War II.

In 1949 the Division of Parks was elevated to the Bureau of State Parks within the Department of Forest and Waters. Five forestry and state parks regions were established headed by a regional forester. These were abolished in 1953 and The Bureau of State Parks was returned to division level within the Bureau of Forestry. By 1955 there were 45 state forest parks, 5 state historical parks, 4 commissioned parks and 45 state forest picnic areas on state forest land.

Governor Leader signed the Oil and Gas Lease Fund Act in 1955, which provided for the development of state parks. This is commonly referred to as Dr. Maurice Goddard's 25-mile rule. It was his vision to place a state park within 25 miles of every resident in the Commonwealth. There were 14 state parks developed as a result of this legislation between 1955 and 1962. Ten of these were located away from state forest land.

Management philosophies and objectives for parks were rapidly evolving. It became apparent that the management of parks was moving in a direction that was not always compatible with management philosophy for state forest land. Because of this, the Division of State Parks was

once again elevated to bureau status in 1962. Unlike the shifting of administrative responsibilities between state forests and parks in the past, this separation allowed them to evolve independently. The current structure of these two agencies is a result of this decision.

In 1970 Governor Raymond Shafer signed Act 275 creating the Department of Environmental Resources. This legislation placed the resource agencies and the environmental regulatory agencies into a single department. Natural resource concerns soon took a back seat to environmental regulatory priorities. As a result bureau programs, including recreation, began to suffer.

Although this action created difficult times for the bureau, there were a few major accomplishments. In 1978 the National Scenic Trails Act provided funding for trail relocation and construction. This led to the development of the state forest trail system and many cross-country ski trails.

The Pennsylvania Economic Revitalization Act 104 (PCC) OF April 10, 1984 was the largest building construction, maintenance and improvement effort since the CCC. The main focus of this program was to provide disadvantaged youth ages 18 to 25 with work experience, job training and education on major public work programs. Their projects included the construction, improvement and maintenance of many recreational facilities and trails.

The current era, sometimes characterized by conflicting uses on state forest land, began sometime around 1970. Modern technology and changing socio-economic conditions resulted in a population that had more leisure time to spend on recreational activities. New technology resulted in the development of off-road vehicles, and improvements and new conveniences were developed for traditional outdoor-related recreational equipment.

The snowmobile was the first off-road vehicle to find its way on to state forest land in large numbers. Snowmobiles were considered to be appropriate for state forest use. Soon after its appearance on state forest land, conflicts began to occur with other users. Traditional users were complained about noise and competition for the trails. Soon after the introduction of the snowmobile other users saw state forests as places to enjoy their recreational pursuits (e.g., all-terrain vehicle riders, mountain bikers, mushers, equestrians and hang gliders). These sports are still looking to the Bureau of Forestry to provide a place for them on state forest land.

In 1995, Governor Tom Ridge signed the Conservation and Natural Resource Act. This legislation split the Department of Environmental Resources and placed all natural resource agencies in the Department of Conservation and Natural Resources. Once again the resource agencies were given cabinet level attention. This legislation restated the purpose for which state forest land was created. The language stated that state forest land is to "Furnish opportunities for healthful recreation to the public".

New recreational equipment and conveniences continue to be developed. More and more people are traveling longer distances to take advantage of the recreational opportunities that state forest land provides. Many of these visitors are unaware of their impact on forest ecosystems and their philosophies do not always agree with those of the traditional user. Some have complained that certain activities are obtrusive and do not belong on state forest land. Others are of the opinion that most uses can be accommodated but perhaps not on the same trails or areas. Some traditional users are fearful that their use may be overly restricted as the number of new users increase. There are some groups that have been actively maintaining trails for years on state forest land and are critical of others that use these "adopted" trails.

Opportunities for conflict are much greater today because of the variety of recreational activities available and the increase in the number of visitors using state forest facilities. The bureau is working to develop solutions to the problem. The recent hiring of forty-two state forest rangers is the first step in improving communications and safety for all state forest visitors. The ranger's role is to provide resources for public safety and for public contact.

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Recreation Inventory

The first step in the recreation planning effort is to inventory existing uses of State Forest land. The recreational use of State Forest land is quite varied. Some of the most common activities include scenic driving, hunting, camping, hiking and nature watching. Some of the less common uses include hang gliding, dogsledding, and kayaking. Some forests accommodate all these uses and some only a few. The following sections give an overview of the more common activities.

Non-motorized Recreation

Camping

The Bureau of Forestry manages camping in three distinct categories: primitive backpack camping, motorized camping and group camping. Primitive backpack campers are those who camp at undeveloped sites and for not more than one-night. These camping opportunities are normally located along trails, although virtually all State Forest acreage, with the exception of Natural Areas, is open to such use. The State Permits are not required for this type of camping unless the camper plans to spend more than one night at a campsite.

Motorized camping is done by the roadside, and as the name implies, it is done in close association with a motorized vehicle. The vehicle continues to be used for storage or transportation during the camping experience. This is unlike backpack camping where the camper carries all their gear for a day or more away from their vehicle. Motorized camping requires a permit from the District Forester and is obtained by contacting the local district office. As with primitive camping, additional rules can be found at

<http://www.dcnr.state.pa.us/forestry/picnic.htm> and some districts may have additional requirements.



The third type of camping is group camping. It is defined as camping with ten or more people. Forest managers typically restrict these activities to sites where there will be little or no environmental impact. This type of activity requires a special activities agreement available from the forest district office serving that area.

Picnicking

Picnicking is permitted anywhere on state forest land. In addition, the Bureau of Forestry maintains 27 accessible picnic areas with pavilions, tables, parking areas, and restrooms.

Leased Campsite Users

This recreational group leases state forest land for their cabins. These cabins are primarily privately owned. A small parcel usually ¼-acre in size is leased for a renewable 10-year term. The sites were first leased mostly to hunting groups in the first half of the 1900's. The long-term lease allowed them to construct small cabins for recreational use on the site. This program was started in 1913 and continued through 1970. However, in most cases existing leases may be transferred to new owners, provided the new lessees are Pennsylvania residents. Today 4,006 campsite leases are administered in 16 state forests.

Hunting and Trapping



Hunting is a recreational activity, but in many cases it also plays a key role in sustainable forest management. Forests can only be sustainably managed if balanced populations of wildlife are maintained. This is particularly true for herbivores, such as deer. If left to multiply unchecked, deer will eat the entire next generation of understory plants in a given area. If generations of new seedlings are lost, the forest soon loses its ability to renew itself following disturbances. Likewise trapping can help

keep rodents and other wildlife in balance with their habitat. Thus hunters and trappers provide a valuable service to the public, while enjoying their sport.

The Bureau of Forestry is the Commonwealth's largest landowner. Nearly all of Bureau's 2.1 million acres is open to public hunting and trapping. There are over 5,100 miles of trails for foot travel open to allow hunters and trappers access to this large public landholding.

In addition, the Bureau of Forestry maintains 19-gated roads in 14 State Forests that are opened seasonally for disabled hunters. Maps and information on these areas can be obtained from district offices.



Fishing

State forest land has an abundance of streams, ponds and lakes that supply opportunities for cold-water and warm-water fishing. State forests have some of the most pristine waters in the Commonwealth and they support abundant fish life. The Department of Environmental Protection classifies 2,970 miles of waterways as high quality and 626 miles of waterways are classified as exceptional value. In addition the Fish and Boat Commission classifies 207 miles as wilderness trout streams. http://sites.state.pa.us/PA_Exec/Fish_Boat/mpag1.htm

Hiking

Hiking trails have been developed in 19 State Forests. Hiking trails may be divided into at least five categories: National Scenic, National Recreation Trails, Keystone Hiking Trail system, local district trails and interpretive trails. [Recreational Trails Database Totals](#) (Adobe PDF - 57 Kb)

National Scenic and National Recreation Trails are designated by the National Park Service and often travel across state boundaries. The Appalachian Trail, a National Scenic Trail, is partially located on state forest land. Portions of two National Recreation Trails, the North Country Trail and Laurel Highlands Trail are located on state forest land. There are 69 miles of National Scenic Trails and 51 miles of National Recreation Trails on state forest lands.



Another type of trail is the State Forest Hiking Trail. It is of regional importance and often travels through more than one State Forest. These trails are usually maintained by volunteer hiking groups with varying amounts of assistance from forest districts. Most of these trails were formerly part of the district trail network. Many sections are designated for hiking use

only. There are 18 Keystone Hiking Trails. About 14% of all trails on state forest land or 713 miles are Keystone Hiking Trails. These trails each have their own maps and/or guidebooks. A list of the organizations maintaining these trail guides is listed on the back of a Bureau of Forestry map entitled Hiking Trails in Pennsylvania. It should be noted that this map shows 16 additional trails of regional importance besides State Forest Hiking Trails. District public-use maps also show these trails.

Local district trails are by far the largest category of hiking trail. 86% of state forest trails or 5,100 miles are local district trails. They are of great local importance for accessing state forest land. These trails are generally open to a wide variety of user groups, not just hikers. Therefore, they are sometimes referred to as shared-use or multi-use trails. Bureau of Forestry personnel maintain these trails with considerable volunteer help on some segments. Many district trails appear on public-use maps and separate maps have been developed for some shared-use trails.

The last category of trail is the interpretive trail. Seven Districts maintain over 40 miles of interpretive trails designed to educate the public about the forest environment. Most sites have a trail-head parking lot and information signs maintained by Bureau of Forestry. Maps and/or guidebooks for each trail are available at district offices.

Mountain Biking

Eleven State Forests maintain 447 miles of designated trails for mountain bicycling with another 3,353 miles open for use. Public-use maps are available in each district showing these trails.

Many rail trails have been developed for mountain biking on abandoned railroad grades throughout the State, and many transect the State Forests. Many have been surfaced specifically for this use and the bicyclist does not have to worry about motorized vehicles on these trails. Some rail trails such as the 62-mile Pine Creek rail trail have developed trailheads and camping facilities. Most of these trails also have specific trail maps developed for users. Maps for trails in the State forest are available from the district offices.

Most district trails also permit mountain biking. Those not permitting mountain bikes will be posted as closed to that activity. Some districts have produced maps either specifically for mountain biking or for specific trail systems that are multi-use trails. The best source for other district trails open to mountain biking is the public use map available from District offices.

Horseback Riding

Horseback riding is a rapidly growing activity on state



forest land. Twelve State Forests maintain over 616 miles of trails designated for Horseback riding with a total of 3,728 trail miles that are available for use. In addition, 1.9 million acres of state forest land is available for cross-country riding. Only Natural Areas, Keystone Hiking Trails and certain other areas posted closed are off limits to equestrians.

Several districts have developed equestrian trails specifically designed for horses. Although these trails were designed for horses, other trail users are welcome. These horse or equestrian trails have large trailhead parking areas and maps are available at district offices.

Canoeing/Kayaking/Boating/Rafting

Pennsylvania is second only to Alaska in the number of miles of streams in one state. There is also an abundance of lakes and ponds. This means that there are many great opportunities for water activities in the Keystone State. These activities can be divided into at least three categories: Canoeing/kayaking, boating and rafting.

Canoeing on Pennsylvania's streams has a long history dating back to the Native Americans. European settlers used the streams for transportation and most of our first towns started on their banks. Today, many of Pennsylvania's stream banks have been cleared and developed. However,



many miles of Pennsylvania's state forest streams are still relatively wild and remote. There are 5,132 miles of rivers and streams on state forest land. Potentially, many of these waters are navigable and open to canoeing and kayaking. Six Forest Districts have developed water trails on waters that transect state forest. The water trails are more fully described in the individual forest supplements. This link delivers real-time information on stream flow that can aid in

determining whether or not a stream or river may be navigable for you type of vessel.

<http://waterdata.usgs.gov/pa/nwis/rt>

The Bureau of Forestry also has management responsibilities of all unwarranted and unpatented rivers islands in the State. These islands offer some excellent recreational opportunities. Today, the Bureau partners with several volunteer groups that design, develop and maintain river islands trails throughout the Commonwealth. These volunteers also serve as trail stewards for maintenance, monitoring resource impacts and tracking public use. Many of these river island groups produce maps and brochures describing the trail. The trail maps will show access sites and river islands designated for day use and primitive camping.

Boating typically occurs on the lakes and ponds, although some of the larger rivers on state forest land are good for boating too. The Bureau of Forestry has several lakes and ponds larger than 5 acres that can be used for boating along with many smaller ponds. The Bureau of Forestry has district public-use maps that show state forest lakes, access roads and parking areas. See boating guidelines for the permits required.

Finally, rafting occurs mostly on the white water stretches of state forest streams. The most notable of which is the Pine Creek through the Pennsylvania Grand canyon. Private companies provide the rafts. The Bureau of Forestry has developed launch sites, parking and camping facilities along the Pine Creek.

Cross-Country Skiing

The Bureau of Forestry maintains 560 miles of cross-country ski trails in 15 districts. Trail maps are available from district offices. Potentially all 3671 miles of state forest trails are open to this use. Each district has a public use map showing roads and trails. The Bureau of Forestry also has a toll-free number listing snow conditions across the state and a website:

www.dcnr.state.pa.us/forestry/snowmobile/trailconditions. It is up-dated twice a week during the winter months by each district.

Birding/ Nature Observation

Bird watching and nature observation are uses that occur through out the 2.1 million acres of state forest land. The best locations for these activities depend on the habitat requirements of the species involved. The Audubon Society has designated certain areas of state forest land with unique or unusual bird species as Important Bird Areas. These parts of the state forest have particularly large and unique habitats for some unusual bird species. Most state forest lands have

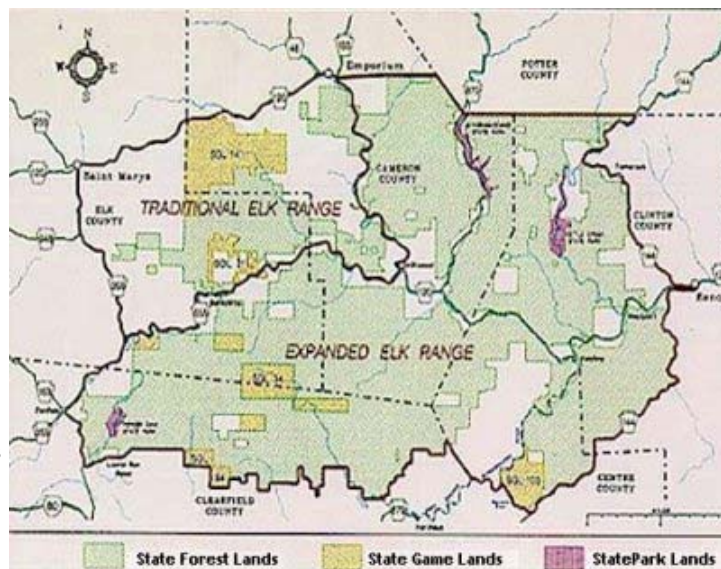
diverse habitats and support great numbers of birds. More information on important bird areas can be found at www.audubon.org/bird/iba



State forest land with its many roads and trails and generally quiet environment is ideal for nature observation. A public use map of the roads and trails is available from each district to aid nature observers. Natural Areas and Wild Areas are managed with this objective in mind, but the entire state forest system is maintained in a largely natural system. Nature photographers and artists also find an abundance of natural settings on state forest land.

Elk Viewing

Elk were extirpated from the Commonwealth in 1867. In 1913 elk were reintroduced into Pennsylvania. Since 1913 through cooperation with the PA Game Commission, the Rocky Mountain Elk Foundation and many others, the Bureau of Forestry has taken an active role in the restoration of a healthy elk herd on State Forest land in north central Pennsylvania. The herd has grown rapidly in recent years to an estimated 700 animals in 2002. The elk range covers 865,000 acres of land in northcentral Pennsylvania. The Elk, Moshannon and Sprout Districts are all actively involved in the



restoration project. Some of the activities include habitat enhancement by creating food plots, Elk relocation into new areas and land acquisition for additional habitat. Most elk viewing is done at viewing areas or from a vehicle along public roads. In cooperation with others, elk viewing vistas and parking areas are maintained for this use. Also, in cooperation with many partners, food plots are being intensively maintained in support of elk viewing. The most popular elk-viewing site at Winslow Hill attracts 70,000 visitors per year to the region. There is an Elk Expo held in late September that attracts elk viewers to St. Mary's and state forest lands.

Elk viewing can be enjoyed through out the elk range in northcentral Pennsylvania. A scenic Elk Highway Scenic Corridor has been developed in cooperation with the Penn DOT and others.

Motorized Recreation

Scenic Driving/Pleasure Driving

This is the largest recreational use of state forest lands. Most recreational users participate in this activity coming to and from the state forest, but for many this is the sole purpose of their visit to state forest land. The beauty of the forest, the solitude, tumbling mountain streams, scenic vistas, and ever changing colors, attract great numbers of visitors.

The Bureau of Forestry maintains many miles of roads and beautiful vistas open to drivers. The Bureau of Forestry produces public use maps to help drivers find there way through the backwoods. Some districts have developed written automobile tour routes and guide books as an

aid to pleasure driving. The Bureau of Forestry also has a toll free number in the autumn describing up-to-date foliage colors across the state for scenic drivers.

Snowmobiling

41,101 snowmobiles were registered with the Department of Conservation and Natural Resources in 2000. More than 1,358 miles of snowmobile roads and trails are maintained in 14 districts across the state. Snowmobile riding on state forest land is restricted to this system. Many miles of these roads and trails are groomed when snow conditions permit. The Bureau of Forestry has a toll-free number listing snow conditions across the state and a website:

www.dcnr.state.pa.us/forestry/snowmobile/trailconditions. It is up-dated twice a week by each district during the winter months.

All Terrain Vehicle Riding

All terrain vehicle ownership is at an all time high in the Commonwealth and growing at an enormous rate. Over 101,985 ATV's are registered with the Pennsylvania Department of Conservation and Natural Resources. In one year the number of ATV's has more than doubled making the growth in the last several years almost exponential. Beginning in the 1970's the Bureau of Forestry opened limited trails to ATV use in Districts 12 & 15. Today the ATV trail system has grown to over 214 miles of trails in 10 different State Forests. Subsequently the damage realized from ATV use has continued to increase, most of which is from illegal use. It is the policy of DCNR to not significantly increase the current ATV trail system on existing state forest land. DCNR is also targeting development of ATV activities to private, municipal, and county lands where the focus can be solely on motorized recreation. The development of trails on private, municipal, and county lands assisted by a DCNR grant program.



The Bureau of Forestry maintains maps of the current trail system and are available from the district office along with specific rules regarding the use of that trail. Additional information on ATV trails can be found at the Bureau of Forestry ATV website www.dcnr.state.pa.us/forestry/atv.

Misc. Recreation

State forest land is host to an almost endless list of other recreational uses. These include astronomy, dog sledding, geo-caching, gold panning, jogging, hang gliding, ice-skating, motorcycle riding, orienteering, photography, rock climbing, rappelling, sleigh riding, sledding, snowboarding, snowshoeing, spelunking, swimming, snorkeling and tubing. All these are allowed on state forest land. Many of these sports are not actively managed, but nonetheless they are enjoyed in the wild and peaceful setting of state forest land.

Adjoining State Parks

In addition to these recreational activities on state forest land, an inventory of recreation would not be complete without mentioning the former state forest lands that are now state parks and environmental education centers. Fifty one state parks and education centers are internal to or border state forest land, many with overnight facilities. Their proximity to state forest lands and many human amenities make them excellent starting points for recreational activities on state forest lands.

Policy Statement

The Bureau of Forestry will provide opportunities for dispersed low-density outdoor recreation that is compatible with maintaining the integrity of the forest ecosystem.

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Goals and Objectives

Goal 1: To provide opportunities for healthful, low-density recreational opportunities that are compatible with maintaining the integrity of forest ecosystems.

Objectives:

- Where environmentally appropriate, provide recreational opportunities to state forest visitors so that the aesthetic, biological and ecological features of the forest can be viewed and enjoyed.
- Maintain road and trail systems and other facilities for state forest visitors .
- Maintain a Keystone Hiking trail system.
- Identify and develop shared-use trail systems that minimize conflicts between user groups.
- Provide recreational sport hunting, fishing and fur-taking opportunities, as well as non-consumptive uses to the public so that wild fauna and flora can be utilized and enjoyed.
- Assess environmental impact of existing and potential recreational uses of State Forest Land
- Develop and implement measures to minimize invasive species introductions in the course of recreational activities
- Maintain our present ATV trail system while developing an environmentally sensitive strategy to address the concerns of all-terrain vehicle (ATV) users.
- Develop publications and other user information that will identify and promote recreational trails and facilities currently available for all users.
- Continue the existing leased forest campsite program.
- Consider the recreational needs of individuals with a disability and facilitate, when possible, their access to facilities and activities.
- Where environmentally appropriate, consider new or expanding recreational pursuits and integrate and coordinate them with existing forest uses.
- Investigate the development of a recreational management zoning system.

Goal 2: To provide information and assistance to the public while ensuring public safety.

Objectives:

- Inform the public about recreational opportunities on state forest lands.
- Inform the public about the laws, rules, and regulations governing recreational activities on state forest land.
- Inform the public about how to minimize environmental impacts due to recreational activities.
- Seek to expand the State Forest Ranger Program to monitor and protect the forest resource and provide for the safety of state forest visitors.
- Provide additional interpretive and educational opportunities to state forest visitors.
- Provide user-friendly and consistent informational material to state forest visitors.

Goal 3: To develop and implement consistent and coordinated recreation strategies throughout the state forest system.

Objectives:

- Cooperate with the Pennsylvania Game Commission and the Pennsylvania Fish & Boat Commission in the management of wild fauna to provide quality recreational opportunities.
- Coordinate with the Bureau of State Parks, other government agencies and organizations in the development and management of joint recreational opportunities and facilities.
- Develop and maintain regional consistency for applying operational guidelines.
- Coordinate with volunteer trail clubs on the routes they maintain when planning significant trail changes.

Goal 4: To cooperate with regional and state interests in the promotion of low density, ecologically sound tourism opportunities associated with state forest lands.

Objectives:

- Work with tourist promotion agencies and local communities in fostering tourism opportunities that are compatible with the bureau's policies, goals, objectives and resources.
- Work with heritage regions/parks and others in fostering tourism opportunities and forest ecosystem education.
- Maintain quality outdoor experiences and minimize adverse impacts to the environment while pursuing the potential for additional tourism promotion.

Goal 5: To promote and effectively use volunteers to increase the Bureau of Forestry's recreational programming, planning and development.

Objectives:

- Promote the use of conservation volunteers in the development and maintenance of recreational opportunities and facilities on state forest lands.

- Educate volunteers on potential adverse impacts of recreational activities and enlist their help in minimizing those impacts.
- Educate volunteers in the identification of invasive species and implement a system to record, prioritize and act on reports of invasions.
- Evaluate opportunities to increase bureau efforts, employee complement, and equipment, for recreation planning and development.

Goal 6: To develop baseline recreational user data for state forest land.

Objectives:

- Develop efficient and appropriate data collection methods and systems that will adequately measure recreational use.
- Conduct district pilot projects to test and adjust these data collection systems.
- Conduct and maintain a comprehensive inventory of recreational facilities and opportunities.
- Monitor and evaluate recreational pursuits on state forest land

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Guidelines and Actions

The Bureau of Forestry has numerous guidelines to direct and coordinate the development of recreational opportunities on state forest land. These guidelines aim to conserve all the values of the forest while allowing recreational useage. They are summarized below and categorized by recreational user groups.

Within the framework of these guidelines we have identified a list of actions necessary to meet the goals and objective listed above. Each forest district lists a more detailed set of actions that will contribute to meeting overall statewide objectives.

Non-motorized Recreation

Camping

Guidelines

The Bureau of Forestry manages camping in three distinct categories. Primitive backpack camping, motorized camping and group camping.

Primitive backpack campers are those who camp at undeveloped facilities. Campers who arrive at their site by boat may also be included in this classification. Permits are not required for primitive camping unless the camper plans to spend more than one night at a campsite or is camping with more than 10 people. One exception, the Weiser State Forest requires permits for all primitive camping. State Forest Rules and Regulations (17. Pa. Code, Chapter 21) list rules regarding campfires, sanitation, littering, closure, parking, and other regulations pertaining to camping. The 1999 paper entitled "Guidelines for Camping on State Forest Lands" further defines permissible camping areas and activities

Motorized camping requires a permit from the District Forester. As with primitive camping the rules can be found in the State Forest Rules and Regulations. Most motorized camping is done at sites chosen by the camper along state forest roads. Some motorized camping is done at specific sites identified by the District Forester specifically for camping. These are termed designated sites. Guidelines for determining the location of campsites are listed in the 1999 paper entitled "Guidelines for Camping on State Forest Lands".

The third type of camping, group camping, is defined by the Bureau of Forestry as more than 10 people at the same site. This requires a Letter of Authorization or in some cases a Special Activities Agreement issued through the District Forester. Guidelines for these permits are further detailed in the 2000 Bureau of Forestry booklet entitled "Policy and General Guidelines for Special Activities Agreements and Letters of Authorization."

Actions

- Produce a standardized camping pamphlet based on Guidelines for Camping on State Forest Lands and State Forest Rules and Regulations. (Goal 2)
- Through regional District meetings maintain consistency concerning camping policies between adjoining Districts. (Goal 3)

- Create a database to monitor motorized camping use. District data should be annually summarized statewide. (Goal 6)
- Examine survey methods and develop a procedure for sampling primitive camping use (Goal 6)

Picnicking

Guidelines

Picnicking may be done anywhere on state forest land subject to State Forest Rules and Regulations (17. Pa. Code, Chapter 21). However, designated state forest picnic areas are governed by a separate law entitled Rules and Regulations for State Forest Picnic Areas (17.Pa. Code, Chapter 23).

State forest picnic areas should be regularly inspected and maintained. Special care must be exercised to prevent health or safety hazards. The District Forester is responsible to see that inspections and maintenance are completed.

An aesthetic buffer will be maintained around designated state forest picnic areas. This buffer will be managed in accordance with the guidelines established in the Silviculture section of this plan.

Picnic areas and their associated facilities should be accessible to, and useable by individuals with a disability.

Actions

- Develop an inventory of picnic area facilities with type of building (i.e. pavilion, latrine, etc.) dimensions of buildings, type of construction and general condition of the building. Create a statewide database to track this information and prepare a report by building types and condition. This information would be useful in planning the number of units needing replacement statewide and within a district (Goal 1 & 5)
- Develop a standardized sampling method for use by Districts to monitor picnic area usage and a database with statewide summary reports. (Goal 6)

Leased Campsite Users

Guidelines

Leased forest campsites, as authorized by the legislature, are limited to Pennsylvania residents. The intent for their use is health and recreation. Their use as a permanent residence or domicile is prohibited. On April 30, 1970, state forest land was closed to additional leased forest campsites. (Leased Forest Campsite Manual) With the advance written approval of the department, a lease may be transferred because of sale of the improvements.

Existing Forest Camp leases will be permitted to remain in Wild Areas and Natural Areas. If a cabin on a Forest Camp Lease is destroyed by fire, storm, flood or other natural causes the lease will be relocated to a site outside of the Wild Area or terminated according to the wishes of the lessee.

The lessee may terminate the lease at any time. The department may terminate the lease on six months notice if the site is required for a higher public use, or on three months notice for justifiable cause.

Management of the forest surrounding a leased forest campsite will be to preserve and enhance the aesthetic value. A 150-foot uneven-age management buffer will be maintained around the existing main campsite building. Around group camp leases a 660-foot uneven-age management buffer will be maintained as described in the Silviculture section of this plan.

Actions

- Combine all memos and update existing Leased Campsite Manual for distribution to district lease administrators. (Goal 1,2 & 5)
- Encourage districts with more than 100 campsites to conduct at least an annual public meeting with campsite lease holders to address concerns and communicate Bureau of Forestry activities affecting them. (Goal 2 & 3)

Hunting

Guidelines

Hunting and trapping is permitted on state forest land, unless otherwise posted, in accordance with the current State Forest Rules and Regulations(17. Pa. Code, Chapter 21) and the laws, rules, and regulations of the Pennsylvania Game Commission.

The fauna section of this plan details specific guidelines for maintaining and creating habitats for specific game species. The silviculture section likewise discusses habitat goals for wildlife.

Certain designated areas are managed according to a 10/98 paper entitled "Guidelines for Pilot Program Allowing Persons with Disabilities to Use Off-road Motor Vehicles on Designated Areas of State Forest Land." An application must be completed and approval must be obtained from the District Forester prior to using these areas. A list of sites available is contained in the paper entitled, "A complete listing of Designated Areas on State Forest Land for ATV use by Disabled Persons and Special Conditions."(10/99)

In addition to these areas the Bureau of Forestry has a number of disabled accessible hunting trails. No application or permit is necessary to use these trails from the Bureau of Forestry, however a letter of approval is required from the Game Commission. This letter documents the individuals status as a person with a disability.

Actions

- Maintain and post a list of roads open just for hunting season in each District. The list should include specific dates of when the road will be opened and closed. (Goal 2)
- Encourage districts to post an explanation of deer fencing along the road side of fences and to invite hunters into the fence to remove deer. (Goal 2)
- Develop a standardized sampling method for use by districts to monitor hunting useage and a database for storing and creating statewide summary reports. (Goal 6)
- Continue to work with the Pa Game Commission and sportsmen's clubs to improve deer and other game management

Fishing

Guidelines

Fishing is permitted on state forest land, unless otherwise posted, in accordance with the current State Forest Rules and (Regulations17. Pa. Code, Chapter 21) and the laws, rules, and regulations of the Pennsylvania Fish and Boat Commission.

Bureau of Forestry streamside buffering policies and road construction and maintenance policies outlined in the Bureau "Timber Management Manual" all contribute to healthy stream environments.

Actions

- Continue water quality and stream improvement projects in cooperation with the Fish and Boat Commission (such as Dirt and Gravel road efforts, Stream liming, habitat improvement) (Goal 1)

Hiking

Guidelines

National Scenic and National Recreation Trails are managed according to trail agreements established between the Bureau of Forestry and the organizations responsible for maintaining them. There is an aesthetic no timber cutting buffer along these trails as outlined in the silviculture section of the State Forest Resource Plan.

A list of the 18 State Forest Hiking Trails is maintained by the Recreation Section of the Bureau of Forestry and is entitled "National and State Forest Hiking Trails"(10/02). These trails have been maintained and promoted by the Bureau, hiking trail clubs and other trail organizations specifically for hiking. There is an aesthetic buffer zone on each side of these trails. State Forest Hiking Trails are marked as described in the "Guidelines for Marking Trails on State Forest Lands" (5/00). The only exception to this is the blue marked Tuscarora Trail.

District trails are marked and maintained according to standards established by the districts. . The marking of District trails is more fully described in the "Guidelines for Marking Trails on State Forest Lands" (5/00).

Interpretive trails are marked and maintained according to standards established by the districts. They are intended to provide the public with natural resource, historical and forest management practice information. All of these have an interpretive trail brochure or interpretive signs on the trail.

Trails have been developed for accessibility of persons with disabilities according to Americans with Disabilities Act standards and ADA standards for Recreational Facilities.

Actions (for all non-motorized trails unless noted otherwise)

- Continue to produce and improve public use maps and specific trail maps (Goal 3).
- Improve bridges and trail surfaces (Goal 1). • Improve marking, blazing and signing (Goal 1,3).
- Evaluate trailhead facilities and improve where appropriate (adequate parking, attractive information sign boards, restroom facilities). (Goal 1,3).
- Promote, advertise, educate and encourage trail volunteers, both individuals and clubs. (Goal 5).
- Maintain the current trail system. (Goal 1).
- Develop a standardized sampling method for use by Districts to monitor useage and a database for storing and statewide summary reports. (Goal 6)

Mountain Biking

Guidelines

Mountain bikes and other non-motorized mechanized equipment are permitted on most local State Forest trails. These trails are maintained by the local forest district and forest conservation volunteers. Districts determine construction standards. Trails developed specifically for mountain biking will be marked with the white international mountain bike symbol on a brown diamond according to the 5/00 "Guidelines for Marking Trails on State Forest Lands. Most local State Forest trails are open to mountain biking. Only Natural Areas, some portions of Keystone Hiking Trails and certain other areas posted closed are off limits.

Actions

- See the non-motorized trail action list covered in the hiking section above.

Horseback Riding

Guidelines

Some shared-use trails have been designed and developed by the forest districts for horse riding. These trails are maintained and promoted by the Bureau, equestrian clubs and other trail organizations. Horse riding is not restricted to designated equestrian trails. Most local State Forest trails are open to horse riding. Only Natural Areas, some portions of Keystone Hiking Trails and certain other areas posted closed are off limits.

Actions

- See the non-motorized trail action list covered in the hiking section above.

Canoeing/Kayaking/Boating/Rafting

Guidelines

Canoeing, kayaking, boating and rafting in Pennsylvania are permitted on state forest land, unless otherwise posted, in accordance with the current State Forest Rules and Regulations and the laws, rules, and regulations of the Pennsylvania Fish and Boat Commission. State Forest Rules and Regulations(17. Pa. Code, Chapter 21) subsections 21.11.Use, 21.12.Mooring and launching, and 21.13 Motorized boats specifically regulate this activity on state forest land. In brief these regulations permit boating on all state forest waters unless posted closed. A DCNR Boat Launching permit is required for launching. Launching is also permissible with a Fish and Boat Commission registration. Motorized boats may only be powered by electric motors. Also, if

camping overnight along a stream from a boat, please see the guidelines in the camping section above.

Some particularly scenic waterways have been designated as water trails. Districts determine maintenance and construction standards for water trails.

Actions

- See the non-motorized trail action list covered in the hiking section above.
- Conduct risk assessment and take measures to reduce risk of invasive species introductions due to boating (see goal 1)

X-Country Skiing

Guidelines

Some trails have been designed and developed by the forest districts for cross-country skiing. Although cross-country skiing is not restricted to designated cross-country ski trails, state forest trails present varying degrees of difficulty. They are maintained by the local forest district and forest conservation volunteers. Construction standards are determined by districts and marking is standardized in the paper entitled "Guidelines for marking trails on state forest lands" (5/00) .

Actions

- See the non-motorized trail action list covered in the hiking section above.

Birding/ Nature Observation

Guidelines

Other sections, such as the Fauna and the Silviculture section of this plan, contain detailed lists of species and more fully describe what is being done to maintain and improve habitats. Pennsylvania Natural Diversity Inventory, Forest Project Reviews, Timber Sale Reservation Guidelines, Natural Areas, and Stream and Vernal Pond Buffer Guidelines are just a few of the many tools used to improve bird watching and nature observation on state forest lands.

Actions

- See the non-motorized trail action list covered in the hiking section above.

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Motorized Recreation

Scenic Driving/Pleasure Driving

Guidelines

Since the 1950's, Recreational surveys have shown pleasure driving to be the number one recreational use on state forest land. For the majority of the public, the forest they know is the forest they see from the road. Management of the roadside views is important in order to maintain or enhance the driving experience as well as the publics' perception of state forest lands.

Vistas should be established to provide views into the forest or through it to any unusual or attractive feature of the landscape. Vistas are important and those now in existence should be maintained and new ones created at advantageous places.

Vistas can create safety hazards for motorists as well as an easy location to dump garbage. When designing and improving vistas, careful consideration must be given to the creation of barriers and parking areas to help alleviate these problems. Where there is a large area to be viewed, parking should be provided along with a sign or signs pointing out important landmarks, counties, distances, etc. Signs are necessary if the vista is to be fully appreciated by those who are not familiar with the local area. The naming of vistas is done by the districts with approval of the State Forester.

Viewscapes are another important consideration when managing scenic driving. Viewscapes are the scenic portions of the landscape that can be seen primarily from a transportation corridor. Public perception should be carefully considered when implementing forest management activities in a heavily visited viewscape.

The recreational value of the forest can also be increased by pointing out and explaining interesting features such as unusual forest types or species, geologic formations, or historic features such as abandoned towns, charcoal hearths, logging railroads, old mill sites, etc. These points of interest may include any features of the forest that may be of some general interest to the public.

Actions

- Consider public perception carefully when working in heavily visited viewscales (Goal 1,4).
- Consider the development of district auto tour guides in areas that have numerous points of interest (Goal 2).

Elk Viewing

Guidelines

The elk range and viewing opportunities are being developed with cooperation of a large number of agencies and organizations including but not limited to the Bureau of State Parks, the Pennsylvania Game Commission, PennDOT, the Pennsylvania State Police, the Rocky Mountain Elk Foundation, the National Wild Turkey Federation, and the North Central PA Regional Planning and Development Commission. The state agencies have contracted with Fermata, Inc., a consulting firm, to make management recommendations for development of the region. Development of the region should be in cooperation with the other agencies involved and follow the directions outlined in the 2001 Fermata Report. Current guidelines related to the Bureau of Forestry include developing elk viewing parking areas, developing food plots, patrolling public highways to assist visitors, promote safety, and reduce resident/visitor conflicts, continue to purchase key habitats in the range, and to promote other nature viewing opportunities in the area along with elk viewing. A brochure for visitors has been produced in 2002 entitled "Wildlife Watching in Pennsylvania's Elk Country"

Actions

- Develop state forest lands only to the degree that it is consistent with the concept of low density dispersed recreation and sound ecosystem management.(Goal 1)
- Continue to coordinate with other agencies and organizations involved in the development of the elk range.(Goal 4)
- Continue to support funding and development of food plots.(Goal 1)
- Continue to support development and signing of elk and wildlife viewing areas.(Goal 2)
- Continue to acquire important habitats in the elk range as funding permits.(Goal 1)

Snowmobiling

Guidelines

These trail systems are a combination of connected shared-use trails and public-use roads open for snowmobile use. Snowmobiles are restricted to trails designated for their use. They are maintained by snowmobile clubs, local forest districts and forest conservation volunteers. Trail construction standards are determined by local districts. Snowmobile trails are marked as described in the "Guidelines for marking trails on state forest lands" (5/00).

The use of snowmobiles is regulated by the PA Department of Conservation and Natural Resources (75. Pa. Code, Chapter 77). It is further regulated by State Forest Rules and Regulations (17. Pa. Code, Chapter 21) subsection 21.22 Snowmobiles. Briefly, State Forest Rules and Regulations only permit snowmobile operation on designated trails and designated areas of state forest land. State forest land is only open to snowmobiling following the last day of antlerless deer season to April 1. A valid Pennsylvania registration (or reciprocal state registration) is required.

Actions (for both ATV & Snowmobile Motorized Trails)

- Maintain appropriate signage on all motorized trails (Goal 1)
- Purchase additional specialized equipment for trail development and maintenance (Goal 5)

- Continue to produce specific trail maps (Goal 3) · Maintain water crossings and trail surfaces (Goal 1)
- Improve trailhead facilities (adequate parking, attractive information sign boards, restroom facilities) (Goal 1,3)
- Promote, advertise, and encourage volunteer participation from motorized recreation clubs (Goal 5)
- Develop a standardized sampling method for use by Districts to monitor trail and trailhead useage and a database for storing and statewide summary reports. (Goal 6)

All Terrain Vehicle Riding

Guidelines

ATV use is regulated on state forest land by State Forest Rules and Regulations subsections 21.23a All-terrain vehicles, 21.24 Spark Arresters, and 21.25 Parking. ATV use is further regulated by the Snowmobile and ATV Law (Chapter 77 of the Vehicle Code, Title 75).



Riding on state forest land is restricted to designated areas only. These trails are divided into summer and winter use trails to reduce the impact of vehicle use on soils, trails, and streams. Summer Trails are open from Memorial Day weekend to September 24. Four trail systems are also open in the winter from the day after antlerless deer season until April 1.

ATV trail marking has been standardized as a black ATV on a green diamond background. Trail construction standards are set locally the District Forester.

Actions

- Maintain the current system.
- Assess the environmental impact of existing trails, monitor to ensure that use is environmentally sound and take appropriate action where environmental damage is observed (Goal 1).
- Take measures to limit introduction of invasive species along ATV trails.
- Assess potential impacts to wildlife habitat, movement, and reproductive ecology as a result of trail use.
- See the motorized trail action list covered in the snowmobile section above.

Miscellaneous Recreational Activities

Guidelines

Many miscellaneous activities occur on state forest land. These include astronomy, dog sledding, geocaching, gold panning, jogging, hang gliding, ice-skating, orienteering, photography, rock climbing, rappelling, sleigh riding, sledding, snowboarding, snowshoeing, spelunking, swimming, snorkeling and tubing. All of these activities are permitted unless they are in conflict with State Forest Rules and Regulations (17. Pa. Code, Chapter 21).

Others are regulated directly. Motorcycle riding is detailed in subsection 21.23 Trail bikes and other off-road vehicles and subsection 21.24 Spark Arrestors. Gold panning is regulated by a 1996 policy administered by the Minerals Section. Hang gliding sites are developed by district standards in cooperation with gliding clubs and they are restricted to use by fully trained pilots. Geocaching is another new activity and the Bureau of Forestry, Recreation Section maintains a policy dealing primarily on the placement and maintenance of caches.

Actions

- Monitor new recreational uses of state forest lands and evaluate their impact on the environment to develop policies that protect the environment and all state forest users.

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Monitoring

- Assess the degree to which trails are facilitating invasive species introductions.

- Conduct a risk analysis regarding accidental introduction of invasive plant or animal species through recreational boating and take action as appropriate to reduce risk.
- Assess impact of trails on wildlife habitat, movement and reproductive ecology.
- Create a monitoring and early-response system (using volunteers where feasible) for new invasive species introductions in high-use areas.
- User Days (from district specific inventories & surveys).
- Trail/Area closures and opening relating to degradation (reporting form needs development).
- Informational material developed and produced.
- Public satisfaction (surveys, number of complaints, trail logs, public meeting input).
- Number of Incidents/Warnings/Citations (within district).
- Tourist promotion material developed.
- Fiscal allocations to recreation cost functions (ATV, snowmobiles, Key 93, Growing Greener, etc.).
- Personnel time working on recreation (AMIS Reports).
- Number of Volunteer Hours.
- Number of Forest Rangers.
- Number of ADA compliant facilities.

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Critical Research Needs

Recreational use surveys of state forest land.

Accurate information regarding the level of recreation use is necessary for a variety of reasons, including forest planning, budget allocation and measuring user satisfaction. Current methods utilized by the Bureau of Forestry of estimating recreation use are inadequate. In response to these needs the Bureau of Forestry needs to implement a process to measure recreation visitation as a part of its annual inventory and monitoring efforts. The data collected will allow the Bureau to better understand its customers and assess the success of the Bureau's recreation management programs.

A comprehensive assessment of the present and projected future environmental impacts associated with recreational use of State Forest Land is also necessary. Decisions regarding potential expansion of recreational activities must be made with sufficient information in hand to adequately address the potential for environmental damage.

Explore the feasibility of requiring weed-free (horse) feed to limit invasive species introductions.

Criteria & Indicators

Environmental

- Extent of area by forest community type in protected area categories.
- Extent of areas by forest community type in protected areas (natural / wild areas, plant sanctuaries) defined by size/age class or successional stage.
- Percent of water bodies in forest areas (e.g. stream miles, lake acreage) with significant impairment.

Economic

- Level of expenditure on research and development.

Social

- Acreage of state forest lands.
- Number of miles of roads open/closed to public access.
- Mechanisms in-place to provide opportunities for public input in decision-making related to state forest management.
- Central depository for data collection, monitoring efforts and research are in place.
- Level of expenditure on research, information and education monitored.
- User Days (from district specific inventories & surveys).
- Trail/Area closures and opening relating to degradation (reporting form needs development).
- Public satisfaction (surveys, number of complaints, trail logs, public meeting input).
- Number of Incidents/Warnings/Citations (within district).
- Number of Volunteer Hours.

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Protecting the Trails, Environment and Rights of Others

Every ATV and snowmobile rider must be an ambassador for the sports. Please give careful consideration to your effect on the trails, environment and others. The future of your sport depends on it.

Minimizing environmental impact

Every effort should be made to minimize the impact of your machine on the trail and surrounding environment. Using skill and common sense you can negotiate various obstacles and riding conditions that have the potential to cause damage. Remember, areas closed to ATVs and snowmobiles are done so for a reason; please respect these special areas.

The following are some suggestions offered by Tread Lightly! Â®, a non-profit organization dedicated to protecting the outdoors and outdoor recreation through responsible practices:

- Stay on designated roads and trails or other areas open for use.
- Avoid "spooking" livestock and wildlife you encounter.
- Cross streams at designated crossings only.
- Use existing campsites whenever possible; avoid building fires.
- Cross obstacles at an angle, one wheel at a time.
- Don't straddle large rocks.
- Avoid mud if you can while remaining on the road or trail.
- Turn into ravines or large depressions at about a 45-degree angle.
- Straddle ruts, even if they are wider than your vehicle. This will keep your vehicle level.
- Lower the tire pressure to where you see a bulge in your tire to give you better traction and provide for a smoother ride.
- Avoid riding the brakes and clutch which can lead to brake failure.

Trail etiquette

Many times ATV riders will come in contact with other user groups sharing the same lands, roadways or trails. It is important to practice common courtesies.

- Be considerate of others on the trail and keep to the right.
- Slow down when passing.
- Ride only where permitted.
- Leave gates as you find them.
- Yield the right of way to bikes, horses and hikers.
- Carry out what you carry in.
- Wave and say 'hello' as you pass.
- Report downed trees and trail maintenance needs to land managers

Report illegal riding

If you see someone riding irresponsibly, off-trail or dangerously, try to record the machine's registration number. Report the activity to the local authority with jurisdiction over those lands. Remember, bad behavior by some individuals can harm the reputation of the entire sport.



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Pennsylvania Biodiversity Partnership Economic Impacts

- [PBP Home](#)
- [What Is Biodiversity?](#)
- [Economic Impacts](#)

Economic Impacts of Biodiversity

Biodiversity has a major impact on the economy of Pennsylvania in the form of revenue and jobs created in the state.

- The forest products industry in Pennsylvania provides 90,000 jobs in 2,500 firms and contributes more than \$4.5 billion to the economy. As an added benefit, wood products are made from renewable resources that are recyclable and biodegradable.
- In 1996, activities associated with watching, feeding, or photographing wildlife generated \$1.8 billion to Pennsylvania's economy, including more than \$236 million contributed by visitors to the state.
- Nearly 20 percent of Pennsylvanians hunt, trap, or fish, spending more than \$1 billion annually in pursuit of these outdoor sports.
- Thousands of Pennsylvanians and visitors to our state spend many hours enjoying our natural wonders through hiking, biking, crosscountry skiing, and other outdoor recreation.

Last Updated: May 06

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National Park Service
U.S. Department of the Interior



Gettysburg National Military Park

Nature & Science



(CAROLYN DAVIS, NATIONAL PARK SERVICE)

Natural grasses on Little Round Top

Gettysburg National Military Park is the site of the American Civil War Battle of Gettysburg, the Soldiers' National Cemetery and the commemoration of the great battle of Civil War veterans. Significant sites on the battlefield began to be preserved almost immediately after the 1863 battle, and the park came under federal ownership in 1895. Administered by the National Park Service (NPS) since 1933, the park now incorporates a significant portion of land across which the battle, its aftermath and the commemoration occurred. The park attracts 1.8 million visitors each year and is open year-round. It offers visitors hiking trails, scenic car tours on over 40 miles of roads, and beautiful vistas overlooking the battlefield and nearby town. There are also over 1,400 monuments and 400 cannons, which dot the landscape.

The park is situated in the Piedmont Province east of Appalachian Mountains in south central Pennsylvania, encompasses over 5,989 acres of land. The park is fifteen miles east of South Mountain, which rises to 2,000 feet above sea level. Within the park are gently rolling hills and valleys with elevations averaging between 500 to 580 feet above sea level. The landscape is a mosaic of mature and maturing woodlands and woodlots, agricultural fields, pasturelands and intermittent streams which provide habitat for 187 bird, 34 mammal, 17 reptile and 15 amphibian species documented to date. Floral inventories have recorded 553 species of vascular plants, of which 410 are native.

Since 1863, natural succession and human development has changed the natural appearance of the landscape and historic battlefields. While some vegetation features (thickets, woodlots and woodlands) were removed by man over the years, others were overgrown by nature,

becoming dense and containing many non-native species. In addition, some historic fields, pastures, and other open areas are covered by non-historic vegetation. In 1999, the Gettysburg National Military Park General Management Plan /Environmental Impact Statement (GMP/EIS) was approved, outlining goals for rehabilitating the 1863 cultural and natural features that impacted the battle. The plan includes such projects as the replanting of historic woodlots, orchards, and also the removal of non-historic vegetation. Work is also underway to re-establish original fencelines, lanes and trails, recreate historic view sheds, as well as maintain the integrity of the historic farmsteads. The management plan included an Environmental Impact Statement, which considers courses of action that would have the least amount of impact on species in the park.

**Did You Know?**

The Eternal Light Peace Memorial at Gettysburg National Military Park was the result of a cooperative effort between veterans of the North and South. It was dedicated by President Franklin D. Roosevelt on July 3, 1938 during the 75th Anniversary celebration of the battle of Gettysburg.

Last Updated: December 08, 2006 at 16:05 EST

National Park Service
U.S. Department of the Interior



Gettysburg National Military Park **Environmental Factors**



(C. DAVIS, NATIONAL PARK SERVICE)

A box turtle attempts to cross a park avenue. Increasing traffic on park roads puts park wildlife at risk.

With almost 2 million visitors a year, the natural resources of Gettysburg National Military Park are prone to stresses from pollution, traffic, and nearby development. It is the mission of the park *"to preserve and protect the resources associated with the Battle of Gettysburg..."*. Many features park managers strive to preserve are natural features such as topography, wooded areas, thickets and wetlands; which were all present during the battle. At the time of the battle these features provided cover and concealment for attack and retreat.

Today the park faces a different kind of battle. With the increased mobility of our advancing society, the park is experiencing ecological changes. Changes range from the introduction of invasive exotic plant species to the developing of lands surrounding the battlefield. Park managers are taking an active role in addressing these changes with an adaptive management strategy. As scientific research provides protocols for monitoring the parks present state, we are able to deduce areas of concern that need assistance. Using research as tools, park managers can make decisions based on sound ecological or historical facts to ensure park resources are being protected. Volunteers, local organizations, and university researchers

provide additional assistance in identifying environmental concerns and making management decisions.



Did You Know?

John Burns, a 72 year old veteran of the War of 1812 and resident of Gettysburg, fought side by side with Union soldiers in the first day of the battle of Gettysburg in 1863 and was wounded several times. His service is commemorated by a battlefield statue at Gettysburg National Military Park.

Last Updated: December 08, 2006 at 14:07 EST



Gettysburg National Military Park **Natural Features & Ecosystems**



(CAROLYN DAVIS, NATIONAL PARK SERVICE)

A wetland area of the battlefield.

National Parks are widely recognized for their inspiring scenery. At Gettysburg National Military Park the visitor is offered a step back in time to 1863. A walk down a historic lane or park avenue invites the visitor to reflect on the events that occurred here and reflect on events that are occurring in their present day lives. The park's 5,989 acres provide opportunities for both naturalist and historian to learn and reflect upon the various components of the cultural landscape.

Gettysburg National Military Park comprises a mosaic of pastoral landscapes and forested knolls, with pockets of dispersed wetland and intermittent streams. Over 2,300 acres of the park's landscape are planted in crops, pasture, or meadows providing the visitor with a glimpse of the local agrarian lifestyle. Over 1,600 acres of woodlots and forested habitat comprise several successional communities, from mature oak/hickory to early scrub-shrub.

Wetlands dot the landscape roughly totaling 148 acres of palustrine wetland and over 26 miles of associated riparian habitat.

The natural landscape offers a respite to the ever increasingly busy schedule of the modern day visitor. The historic landscape is interwoven into the fabric of existing natural features, such as woodlots, wetlands and geology. These features provide visual stimulation as well as academic stimulation. Ongoing studies to understand forest regeneration in woodlots at Gettysburg has been a continuing study since 1985. Wetlands and their functional values in terms of ecological niches and filters have been important factors in rethinking the agricultural special use program. Granite rock outcroppings at Devil's Den are recognized for more than strategic positions; they are records of processes that have occurred throughout the earth's natural history.

In 1999, the Gettysburg National Military Park GMP/EIS was approved, outlining goals for rehabilitating the 1863 features that impacted the battle. Components of the plan included replanting missing historic woodlots, orchards and thickets and removal of non-historic vegetation. These landscape changes were designed and proposed to aid interpretation of the battle story. In addition, the methods of landscape change were thoughtfully considered to create the least amount of impact, in context with park objectives, on species known to use the park.

**Did You Know?**

President Abraham Lincoln was not the featured speaker at the dedication of the Soldiers' National Cemetery at Gettysburg. He was asked to provide "a few appropriate remarks", recognized today as one of the greatest speeches of his presidency.

Last Updated: December 08, 2006 at 15:53 EST



Gettysburg National Military Park **Prairies and Grasslands**



(Z. BOLITHO, NATIONAL PARK SERVICE)

Native grasses found at the Little Round Top area.

Grasslands are considered by many as one of the most endangered ecosystems globally. Grasslands were once abundant in the 1800's when settlers had cleared much land for hayfields and pastures. Today grasslands face danger from fires, human development, and changes in agriculture technology.

Grasslands are important because they protect large amounts of open space and provide wildlife and nesting habitat for specialized species. The ecosystem is especially important to birds such as the Bobolink, Savannah sparrow, and the Eastern meadowlark. Grassland birds require large contiguous patches of grassland habitat for successful breeding. Many grassland birds will only nest in this type of open grassland habitat and decline in grasslands causes decline in breeding birds.

Much of Gettysburg NMP is considered grassland habitat. The park was designated one of several Important Bird Areas in Pennsylvania set aside to protect birds and grassland habitat. In efforts to maintain the characteristics of an 1863 landscape much of the main battle action resource areas are being converted from large agricultural fields to smaller contiguous patches of native grasses. The restored field patterns will better reflect historic 1863 conditions and provide valuable grassland habitat.

Did You Know?

The statue of General Robert E. Lee atop the Virginia Monument at Gettysburg National Military Park was sculpted by F. William Sievers. A similar equestrian



statue to Lee is located on Monument Avenue in Richmond, Virginia.

Last Updated: December 08, 2006 at 11:45 EST

National Park Service
U.S. Department of the Interior



Delaware Water Gap National Recreation Area

Nature & Science



The Water Gap from Kittatinny Point NJ

The recreation area encompasses 67,000 acres of mountain ridge, forest, and floodplain on both sides of the Delaware River in the states of New Jersey and Pennsylvania. Among the more surprising species of animals in the park are black bear, timber rattlesnakes, bald eagles, and, recently, nesting peregrine falcons. Ecosystems include hemlock ravines with bountiful rhododendron and ridgetops with prickly pear cactus.

Forty miles of the Middle Delaware River are within the park, as well as trout streams, lakes, ponds, and some of the highest waterfalls of either state. Water quality is exceptional in this section of the valley. The river's path through the mountains includes the S-curves of Walpack Bend and the Delaware Water Gap.



Did You Know?

... that hemlock groves in Delaware Water Gap National Recreation Area are threatened by a non-native insect, the hemlock woolly adelgid. Hemlocks provide shade for spectacular rhododendron, for trout streams, and for native wildflowers. As hemlocks weaken and die, they are cut down for your safety.

[more...](#)

Last Updated: October 28, 2006 at 12:13 EST



Delaware Water Gap National Recreation Area **Management**

Mission

To provide outdoor recreation opportunities while conserving the natural, cultural and scenic resources of the recreation area. In so doing, the park works cooperatively with surrounding communities and the public to achieve the conservation goals of the Delaware River region.

Significant Natural Area

Delaware Water Gap National Recreation Area is the largest natural area in the entire National Park System between Virginia and Maine and one of the largest protected natural areas in the metropolitan corridor extending from Washington, D.C., to Boston, Massachusetts.

Water Quality

The waters of the Middle Delaware River are of exceptional quality. The 125 miles of the river that run through Upper Delaware National Scenic & Recreational River and Delaware Water Gap National Recreation Area are classified as *Special Protection Waters* which have "exceptionally high scenic, recreational and ecological values." Under the regulations applicable to this category, "no measurable change in existing water quality [is permitted] except towards natural conditions."

Visitor Access

The park is the tenth most visited area in the National Park System with almost 5 million recreational visits each year. Visitation is growing at a steady rate. Much of this visitation is from the nearby, rapidly expanding New York/northern New Jersey and Philadelphia suburban areas.



Did You Know?

... that the Middle Delaware River exceeds ordinary federal standards for clean water. Because of this, special higher standards have been set for the river, so it does not "deteriorate" to being just "clean enough." The river in this park is, and will remain, truly "cleaner than clean."

[more...](#)

Last Updated: September 13, 2006 at 12:59 EST



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Leave No Trace Principles

The Leave No Trace Principles of outdoor ethics form the framework of Leave No Trace's message:

1. Plan Ahead and Prepare (in [brief](#) or in [detail](#))
2. Travel and Camp on Durable Surfaces (in [brief](#) or in [detail](#))
3. Dispose of Waste Properly (in [brief](#) or in [detail](#))
4. Leave What You Find (in [brief](#) or in [detail](#))
5. Minimize Campfire Impacts (in [brief](#) or in [detail](#))
6. Respect Wildlife (in [brief](#) or in [detail](#))
7. Be Considerate of Other Visitors (in [brief](#) or in [detail](#))

Plan Ahead and Prepare

- Know the regulations and special concerns for the area you'll visit.
- Prepare for extreme weather, hazards, and emergencies.
- Schedule your trip to avoid times of high use.
- Visit in small groups when possible. Consider splitting larger groups into smaller groups.
- Repackage food to minimize waste.
- Use a map and compass to eliminate the use of marking paint, rock cairns or flagging.

Travel and Camp on Durable Surfaces

- Durable surfaces include established trails and campsites, rock, gravel, dry grasses or snow.
- Protect riparian areas by camping at least 200 feet from lakes and streams.
- Good campsites are found, not made. Altering a site is not necessary.
- In popular areas:
 - Concentrate use on existing trails and campsites.
 - Walk single file in the middle of the trail, even when wet or muddy.
 - Keep campsites small. Focus activity in areas where vegetation is absent.
- In pristine areas:
 - Disperse use to prevent the creation of campsites and trails.
 - Avoid places where impacts are just beginning.

Dispose of Waste Properly

- Pack it in, pack it out. Inspect your campsite and rest areas for trash or spilled foods. Pack out all trash, leftover food, and litter.
- Deposit solid human waste in catholes dug 6 to 8 inches deep at least 200 feet from water, camp, and trails. Cover and disguise the cathole when finished.
- Pack out toilet paper and hygiene products.
- To wash yourself or your dishes, carry water 200 feet away from streams or lakes and use small amounts of biodegradable soap. Scatter strained dishwater.

Leave What You Find

- Preserve the past: examine, but do not touch, cultural or historic structures and artifacts.
- Leave rocks, plants and other natural objects as you find them.
- Avoid introducing or transporting non-native species.
- Do not build structures, furniture, or dig trenches.

Minimize Campfire Impacts

- Campfires can cause lasting impacts to the backcountry. Use a lightweight stove for cooking and enjoy a candle lantern for light.
- Where fires are permitted, use established fire rings, fire pans, or mound fires.

- Keep fires small. Only use sticks from the ground that can be broken by hand.
- Burn all wood and coals to ash, put out campfires completely, then scatter cool ashes.

Respect Wildlife

- Observe wildlife from a distance. Do not follow or approach them.
- Never feed animals. Feeding wildlife damages their health, alters natural behaviors, and exposes them to predators and other dangers.
- Protect wildlife and your food by storing rations and trash securely.
- Control pets at all times, or leave them at home.
- Avoid wildlife during sensitive times: mating, nesting, raising young, or winter.

Be Considerate of Other Visitors

- Respect other visitors and protect the quality of their experience.
- Be courteous. Yield to other users on the trail.
- Step to the downhill side of the trail when encountering pack stock.
- Take breaks and camp away from trails and other visitors.
- Let nature's sounds prevail. Avoid loud voices and noises

FROM YOUR BACKYARD TO YOUR BACKCOUNTRY



Contact



Shop



Join

LEAVE NO TRACE CENTER FOR OUTDOOR ETHICS

**Pennsylvania Game Commission
Bureau of Wildlife Management**

WILDLIFE DIVERSITY PROGRAM

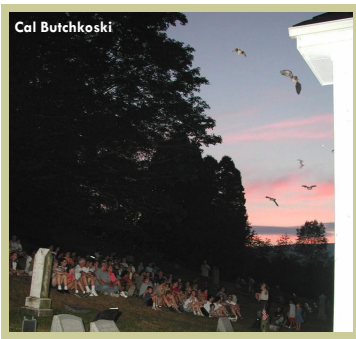
*Protecting and Enhancing Pennsylvania's
Species of Special Conservation Concern and Their Habitats
for Use and Enjoyment by Present and Future Generations*

Annual Report—January 2005

Watching Wildlife is Big Business

One Pennsylvanian in four actively participates in watchable wildlife recreation, such as viewing, feeding and photographing wildlife. Hundreds of thousands of out-of-state residents visit our state to watch wildlife. Experiences such as spotting deer in the fall or looking for songbirds during spring migration are enjoyed by millions of people. Whatever the occasion, a wildlife encounter adds great value to our outdoor experiences and builds appreciation of these resources.

The Wildlife Diversity Program is a significant link to the millions who enjoy wildlife.



Hawk watching is one of the Commonwealth's specialties. Thousands of viewers travel to our central ridges to experience the river of hawks – more than a dozen species - escaping winter's fury to warmer climates, some as far away as South America. Many other events, such as eagle festivals on the Delaware River and bat festivals at Canoe Creek State Park (left), are growing in popularity as people are attracted to marvels of the wild world right here in Pennsylvania. Of course, the vast majority of wildlife watchers do so in their own back yards, tending a bird feeder or enjoying the antics of squirrels.

The Wildlife Diversity Program has long enhanced wildlife enjoyment through studies and publications that provide the background information that feeds this interest. The Pennsylvania Game Commission web site contains extensive information on endangered and threatened species, bird feeding tips, and seasonal references. Newly established viewing guides and viewing areas, developed with federal dollars and in cooperation with partners such as Audubon Pennsylvania, serve this growing constituency of outdoor enthusiasts with new resources for enhanced appreciation and successful pursuit of wildlife experiences.

Translated into action, this broad interest is reflected in participation in projects that help us learn more about our wildlife. Volunteers from the Pennsylvania Society for Ornithology, Audubon Pennsylvania, and local Audubon Chapters conduct surveys for the Commonwealth's 2nd Breeding Bird Atlas. Volunteers who recognize the value of bats are the backbone of the Bat Summer Concentration Survey. The Pennsylvania Biological Survey contributes untold hours of expert guidance to the development of the Commonwealth's federally required Comprehensive Wildlife Conservation Strategy (CWCS). Universities, conservancies, museums, and other non-government organizations contribute to the knowledge necessary to manage all birds and mammals through studies partially funded through federal State Wildlife Grants (SWG).



The Wildlife Diversity Program contributed to these resources:

PGC State Wildlife Grants web page, www.pgc.state.pa.us, select Wildlife on the left, then State Wildlife Grants on the right
Woodworking for Wildlife (nest box plans for birds and mammals) available from PGC The Outdoor Shop, www.pgc.state.pa.us
The Birds of Pennsylvania by Gerald M. McWilliams and Daniel W. Brauning, Cornell University Press, www.cornell.press.edu
Susquehanna River Birding and Wildlife Trail Guide available from Audubon Pennsylvania, 100 Wildwood Way, Harrisburg, PA 17110, telephone (717) 213-6880
Wild Resource Conservation Fund videos - **Season of the Bat**, **On the Rocks** (Allegheny woodrats) and **Traveling Minstrels: Pennsylvania's Songbirds**. To read brief descriptions of these and other videos, visit the WRCF video page, www.dcnr.state.pa.us/wrcf/video.aspx.

In addition to cooperative projects with conservation partners, SWG funds retained by the Game Commission made possible limited-term positions for Regional Wildlife Diversity Biologists who work with private landowners throughout the state. By integrating landowners' objectives for their properties with habitat management for special concern species, these new biologists will provide management plans to mitigate habitat loss, enhance existing habitat, and even create new habitat. With over 85% of Pennsylvania privately owned, this type of land-use planning is essential to the survival and stability of these species.

Other WDP highlights for the year include a record tally of 120 bald eagles during the annual mid-winter count, 15 new nest sites in the summer of 2004, and very good nest productivity. Federally endangered Indiana bats were found hibernating in a new site in Beaver County and there were successes in the continuing effort to provide alternative summer roosts acceptable to Indiana bats and other bat species. Northern flying squirrels, thought to be limited to the Poconos, were found on Warren County game lands adjacent to the Allegheny National Forest. Rock voles, another species of concern, were found in Sullivan County. The addition of ornithologist Doug Gross and mammalogist Greg Turner to the Wildlife Diversity Program's central staff allows us to continue and expand our efforts.

All of these efforts, and many others, are linking together the public's appreciation of wildlife with better stewardship through Wildlife Diversity Program activities.

Dan Brauning, Supervisor
Wildlife Diversity Program



Regional Wildlife Diversity Biologist *Dan Mummert* (right) and landowner *Ed Connor* discuss a spring seep and its potential for wildlife, including amphibians.

The CWCS & PABS



Like nearly every state in the country, Pennsylvania is relying on technical experts to guide the Comprehensive Wildlife Conservation Strategy (CWCS) process.

The Pennsylvania Biological Survey (PABS) is a broadly based group of environmental science professionals and qualified amateurs who serve on technical committees focused on animal and plant taxa, and on standing committees for habitats and ecosystems. Drawn from across the state, PABS members are university researchers and professors, conservancy directors and specialists, curators at natural history museums, and state and federal agency biologists.

Representatives from PABS and other non-government organizations helped the Commissions develop the guiding goals and objectives for the CWCS. PABS technical committees on birds, mammals, fish, reptiles and amphibians, and invertebrates identified the Commonwealth's species of greatest conservation need. The committees are also being consulted to identify species that have extenuating circumstances not reflected in their global or state rankings of endangered, threatened, or at-risk. These circumstances include recent or severe declines, environmental threats (e.g. disease, displacement by invasive species), and habitat threats (e.g. plant disease resulting in habitat loss, habitat fragmentation resulting from development).

Tackling a monumental task, PABS members are writing 150 species accounts for the CWCS, about 90% of the total. After the accounts are reviewed by editors, others members will provide peer reviews for those species most at risk.

This relationship with PABS will:

- Help the Game Commission and the Fish and Boat Commission fulfill the legislative requirement for public involvement.
- Help ensure that the CWCS is technically sound and biologically accurate.
- Help ensure that our conservation partners will assist in the implementation of CWCS recommendations.
- Improve the quality of our State Wildlife Grant project proposals, because investigators and cooperators were involved in developing research and management priorities as part of the CWCS process.

PROTECTED BIRDS



Black and white Warbler
Powdermill Nature Reserve



Sparrow nest
Bob Wood



Goshawk
Powdermill Nature Reserve



Scarlet Tanager pair
Mike Lanzzone



Golden-winged Warbler nest
Bob Wood



Killdeer chick
Mike Lanzzone

A DIVERSITY OF WILDLIFE *The Wildlife Diversity Program again targeted nesting-season survey efforts on a wide variety of birds including, colonial nesters, grassland breeders, bald eagles, ospreys, and peregrine falcons and regionally rare or specialized species. Volunteers, temporary employees, university students, and contractors are some of the partners who help to conduct this diverse array of work.*

The 2nd PENNSYLVANIA BREEDING BIRD ATLAS, a federal State Wildlife Grant project, is now in full swing, with 2004 as the first year of a 5-year field effort. Availability of suitable and sufficient habitat for maintaining viable populations is the single most important factor determining the status and future of our state's overall bird diversity. The results of the first Atlas were used to examine relationships between land cover and breeding bird distributions and helped to point out the importance of habitat diversity and habitat quality to fostering that diversity. The 2nd PBBA will go several steps further, using technologies, like GPS and GIS, not widely available during the first Atlas, to help us greatly improve our knowledge of the distributions of birds in relation to habitats in Pennsylvania.

During this primarily volunteer effort, participants record species, date, a breeding code, habitat, and exact location for every observation. Over 1,600 survey blocks have been claimed (owned) by birders through high-tech, on-line block registration. Participants, known as "block owners," are asked to spend a minimum of 25 hours, spread out over the course of the season, actively engaged in searching for breeding birds within their blocks. Effort also includes time spent in the block at different times of day, to insure that dawn and dusk active species have a good chance of being detected. Computer models determine from land cover data which breeding bird species could be present in those blocks. Block owners are asked to visit as many of the habitats represented in their blocks as possible. Field data is entered at the web site.

The quantitative aspect of this project got started in a big way by seven paid and volunteer top-notch birders who completed point counts in about 600 blocks. Standardized wetland bird protocols were field-tested by the seven point counters. (Other new project features, including modeled habitat mapping and standardized nocturnal surveys, are under development for deployment in 2005.) Despite an invasion of cicadas, volunteers garnered such highlights as the state's first sandhill crane nest and confirmation of endangered and threatened species at new sites - such as sedge wren in York County and dickcissel on territory in Lancaster and Luzerne counties.

In the case of state or regional rarities, especially species of special concern, review and verification of all records will insure the accuracy and credibility of the 2nd PBBA database. Atlas records for species of special concern, in particular, will be important as additions to Pennsylvania's Natural Diversity Inventory database, which helps to conserve species and their habitats in the state. Special surveys usually will not be the responsibility of block owners, but will be done at various times during the course of the Atlas project by field staff working throughout the state.

Additional information is available at the Atlas home page, www.pabirdatlas.org.



Birdwatching for the Atlas are Penn State student Jake Mohlmann and Powdermill Nature Reserve research assistant Adrienne Leppold.

The Wildlife Diversity Program's colonial-nesting bird survey has identified two growing threats to the state's largest black-crowned night-heron and great egret rookery on [Wade Island](#) in the Susquehanna River near Harrisburg – erosion and a rapidly expanding nesting population of double-crested cormorants. The great egret is classified by the state as endangered. The Ornithological Technical Committee (OTC) of the Pennsylvania Biological Survey (PABS) has recommended endangered status for the black-crowned night-heron, currently classified as threatened in the Commonwealth.

The annual Wade Island rookery survey found 171 great egret nests, 128 black-crowned high-heron nests, and 40 double-crested cormorant nests. Since 1996, the number of cormorant nests has increased from 1 to 40.

In an attempt to mitigate the threats, Dr. Terry Master and students at East Stroudsburg University developed models and mock nests intended to encourage egrets and herons to nest on a neighboring island. The OTC and Audubon Pennsylvania worked with the PGC to place 25 plastic models on an adjacent island. Observations will continue into next year.



Double-crested cormorants
At the Wade Island rookery, this invasive species competes with native colonial wading birds that already are threatened and endangered.

[Bald eagle](#) and [osprey](#) studies track the nesting success of these species. Fifteen new bald eagle nests were found in 2004, mostly clustered near currently active nests. Productivity was the big news, with successful nests producing an average of 1.8 young per nest. In Pennsylvania, bald eagle numbers have recovered so much that the OTC has recommended that the state change the species status from endangered to threatened.

The [peregrine falcon satellite telemetry](#) project that began in 2002 allowed the public to follow wandering fledglings from nests in both Pittsburgh and Harrisburg through journals and animated maps on the PGC website. The winter of 2003-2004 provided proof of the harsh realities faced by wildlife – we received confirmation of the deaths of two birds.

On a brighter note, one of the four original travelers, continued to provide information until mid-May 2004. The Pittsburgh female peregrine, fitted with a solar-powered transmitter in 2002, spent two winters in the Delmarva Peninsula of Virginia and, in March 2004, returned to the central New Jersey coast where she'd spent her first summer. Following a dizzying array of movements that included New York, New Jersey and Delaware, no travel was detected after May 19, although the transmitter continued to function. On June 9, WDP Supervisor (and ornithologist) Dan Brauning, accompanied by his son Andrew and Art McMorris, a peregrine monitoring coordinator, plunged through a wall of poison ivy on Great Marsh Island in New York. Andrew found the transmitter hanging from an old piling in the salt marsh. This bird was one of fewer than ten peregrines ever tracked for two years. We hope to hear of her at a nest site, possibly along the New Jersey coast.



Henslow's sparrow

Nationally rare, this species is classified as endangered or threatened in most states in which it occurs. In Pennsylvania, the Grassland Breeding Bird Survey continues to show that our Henslow's are found almost exclusively on reclaimed mine lands, indicating a need to incorporate grasslands into mine reclamation plans.

PROTECTED MAMMALS

HOME IS WHERE THE HEART IS, but there are basic needs that keep the heart beating – food, water, shelter. For us it seems simple – a grocery store within a short drive, tap water, a roof over our heads. But when you think about it, they're not simple at all. The grocery store has a huge production and logistics complex supporting it. Tap water requires infrastructure. Walls of wood, brick or stone support the roof over your head. Human "basics" have become complex and costly.



We think of basics for our furry wildlife as being simple, right? Wrong! Some have strict needs – such as hypogeous fungi (sort of like truffles) for northern flying squirrels, clean water in babbling brooks for the water shrew, and rock crevices in forest habitat for Allegheny woodrats. We can't assign the basics for any one mammal or apply them to all. Mammals are picky, each having its own special combination of basic needs. The landscape changes we've made to create our complex-but-comfortable human habitats often compromise natural designs that provide the basics for wildlife. That makes management of mammal populations increasingly challenging. The future for our wildlife is becoming more and more dependent on research that provides specific knowledge for development of new management techniques.

In the fall of 2003 and spring of 2004, biologist aides conducted surveys of known and potential sites for the state-threatened **Allegheny woodrat**. Of the 19 fall survey sites, old sign was found at 5 sites but no fresh sign was found. In the spring, one new active site, in Centre County, was found and 3 sites only had evidence of past use. One of these, Pennsylvania's easternmost woodrat site, located in the Delaware Water Gap, Northampton County, and isolated from any other active sites, may now be extirpated.

Small mammal trapping data has been collected every three years beginning in 1985 in a tornado-damage study area in Parker Dam State Park, Clearfield County. During the March meeting of the Pennsylvania Chapter of The Wildlife Society, biologist aide Julie Winner presented findings comparing species and small mammal density at three sites – one where remaining timber was salvaged, one un-salvaged, and one control (undamaged). The density of small mammals at the salvaged site, which had both rangeland and forested habitat, was twice that of the control area, while the un-salvaged site had a 74% greater density than the control. Both tornado-damaged sites brought in additional species to those present on the control, including the southern bog lemming and long-tailed shrew. While neither is a species of special conservation concern, both species have limited distribution within the state.

WDP Mammalogist **Cal Butchkoski** and James Hart of The Nature Conservancy completed a protocol for contractors to use in surveying for the state-endangered **least shrew**. Most of Pennsylvania's shrews live in moist, mature forests, but the least shrew is a grassland species that prefers old fields, abandoned pastureland, and meadows of weeds and grass. Populations in the Commonwealth are widely scattered and the density of those populations is low. Adding to the challenge is the fact that conventional small mammal sampling techniques aren't effective on this elusive species.

Pennsylvania's **colonial-roosting bats** provide a valuable ecological service as major predators of night-flying insects. A viable bat population provides economic, environmental and recreational (viewing) benefits.



Friends to bats

Eagle Scout candidate Eric Sassaman, and friends, built a bat condo in Kratzerville, Snyder County. Zion Lutheran church provided the site. There were over 1,300 bats in the church attic, rather than in the belfry.

During the summer of 2003, eighteen volunteer crews and one PGC crew conducted surveys at 51 summer bat concentration sites. These counts resulted in a tally of 58,787 bats in 13 bat box sites, 9 bat condos, 9 barns, 5 utility buildings, 4 churches, 4 occupied homes, 2 unoccupied homes, 2 highway bridges, and 3 other structures. Barns had the highest bat tallies with 23,244 bats exiting the 9 sites. Bats exiting from boxes and condos totaled 9,168. Hopefully, increased use of alternative roosts for bats (boxes and condos) is an indication of growing acceptance of management techniques. The U.S. Army Corps of Engineers built 2 condos at Lake Raystown, Huntingdon County.



Photos by
Cal Butchkoski

During the winter of 2004, surveyors, including PGC personnel, employees of other state agencies, and volunteers, visited 26 [bat hibernation sites](#), known as hibernacula. Twenty-three of the 26 sites contained bats; 14 contained special concern species. The major concentrations of wintering bats (80%) were found in abandoned mines. Indiana bats, the Commonwealth's only federally endangered mammal, were found in a new site – a Beaver County limestone mine gated in 1997. Pennsylvania now has 13 known hibernation sites for the Indiana bat – 6 limestone mines, 1 clay mine, 2 anthracite coalmines, 1 railroad tunnel, and 3 limestone caves. Of those 13 sites, 7 harbor fewer than 20 Indians. Butchkoski and veteran biologist aides Chris Sanders and John Chenger mapped the passages of the privately owned Fayette County fire clay mine to determine their location relative to proposed gas wells. The endangered bats were first found hibernating in the clay mine in January of 2003; three years after the mine had been gated.

Success with alternative shelters

Endangered Mammal Specialist Greg Turner checks an aluminum-shell bat box at Canoe Creek State Park. During summer 2004, endangered Indiana bats (wearing yellow bands) reared pups in the durable artificial roosts.

Because it is an endangered species, the [Indiana bat](#) is the subject of a research and management project conducted in and around Canoe Creek State Park, Blair County. Section 6 funds administered by U.S. Fish and Wildlife Service Federal Aid support the project. So do funds from PennDOT, which plans a highway improvement and realignment project for nearby U.S. Route 22. The park has both hibernation and maternity roosts of the endangered bat. Artificial roosts, in the form of a condo, baffles installed in existing buildings, and bat boxes of several designs have also been provided and are used by both Indians and common little brown bats. The project also includes radio-telemetry to determine foraging areas, travel lanes and spring migration routes, sampling of insect populations in foraging areas, and a biological assessment for the highway project.

In research also presented to The Wildlife Society in March, entomologist and biologist aide Andrew Mehring compared the number and orders of insects captured in light traps placed within and outside of the Canoe Creek Indiana bats' preferred foraging area to recently published studies examining food preferences of other populations of Indians. Although several published studies have found that moths compose the majority of Indiana bat fecal material, two recent Michigan studies identified caddisflies and true flies as the major prey of Indiana bats. At Canoe Creek, the light trap within the preferred foraging area contained more moths than the other two sites. It also consistently trapped the fewest caddisflies and a lower number of true flies than the other sites.



Photos by Andrew Mehring

FEDERAL FUNDING FOR STATE-BASED WILDLIFE CONSERVATION

Since 2002, federal funds in the form of the State Wildlife Grant Program (SWG), administered through USFWS Federal Aid, became available for state-based conservation of species of special concern. At the outset of this program, the Game Commission and the Fish and Boat Commission decided to partner with local conservation interests in high-priority efforts in order to maximize the use of funds. Working with partner organizations, we have been able to intervene in wildlife conservation and management at the state level before species require protection under the Federal Endangered Species Act.



A significant requirement of the SWG program is that each state must produce a draft [Comprehensive Wildlife Conservation Strategy \(CWCS\)](#) and submit it for USFWS Federal Aid approval by October 2005. Each state's CWCS must contain elements including special concern species status, habitat inventory, threats analysis, recovery plans, monitoring and adaptive management, plan updating, coordination with federal, state, and local agencies, and public involvement. Through the efforts and guidance of Wildlife Conservation Planning Coordinator [Lisa Williams](#), significant strides have been made toward the completion of Pennsylvania's plan. Many cooperative SWG projects have provided or are providing species status, habitat inventory, threats analysis, and recovery and management planning. Technical committees of the Pennsylvania Biological Survey (PABS) recommended special concern species to be considered in addition to those already classified as threatened or endangered.

SWG funds retained by the PGC made it possible to add two limited-term biologists to the central staff of Wildlife Diversity Program. Veteran ornithologist [Doug Gross](#) has assumed many duties, allowing program supervisor Brauning more time to administer the WDP's increasing responsibilities resulting from new research efforts, cooperative projects, and formulation of the CWCS. Mammalogist [Greg Turner](#) has expanded the PGC program to include work with northern flying squirrels in addition to supervising field efforts at Canoe Creek. Research can now be expanded to include other species of concern, including the rock vole and West Virginia water shrew. Pennsylvania's threatened Allegheny woodrat population will also receive more attention.

New [Regional Wildlife Diversity Biologists \(RWDB\)](#) are also partially funded by SWG. Following training in the classroom and in the field, they have been in contact with conservation agencies, such as USFWS, U.S. Department of Agriculture, Natural Resources Conservation Service, Pennsylvania Fish and Boat Commission, Department of Conservation and Natural Resources, Department of Environmental Protection, conservation districts, conservancies and land trusts, watershed organizations, and Audubon Pennsylvania, in order to introduce them to the Landowner Incentive Program and its mission, determine how regional biologists can form partnerships to prioritize "focus areas" for species of greatest conservation concern, and obtain landowner contacts.

Located throughout the state, RWDBs will provide habitat management plans for private landowners. Examples of projects include establishing a corridor of six properties to be considered for conservation easements, protecting a heron rookery, cooperating on a greenways project to protect land along an "exceptional value" stream, and contributing expertise on wildlife habitat for reclaimed strip mines and for properties enrolled in DCNR's Forest Stewardship Program.



RWDB Justin Vreeland discusses forest preservation with an audience member after a presentation for the Woodland Owners of Centre County.

COOPERATIVE PROJECTS funded by the STATE WILDLIFE GRANT PROGRAM

Federal Fiscal Year 2003

Migrant Raptor Habitat Use Along the Kittatinny Ridge - A Critical Corridor for Eastern Flyway Birds

Hawk Mountain Sanctuary Association

Conservation-Management Plan for the Threatened Woodrat

Jerry Hassinger

Movement and Habitat Usage by the Eastern Massasauga Rattlesnake in Pennsylvania

Western Pennsylvania Conservancy

Contemporary Population Status and Identification of Spawning Locations of Delaware River Atlantic Sturgeon

Delaware State University

Important Mammal Areas Project, Phase III: Implementation

National Wildlife Federation and Pennsylvania Wildlife Federation

Pennsylvania Invertebrates of Special Concern:

Comprehensive Assessment Essential to Pennsylvania's Wildlife Conservation Plan

Carnegie Museum of Natural History

Habitat Use by Bog Turtles, *Clemmys muhlenbergii*, in a Late Successional Wetland

Shippensburg University

Survey of Rare Species of Fishes, Reptiles and Amphibians in Southeastern Pennsylvania

Academy of Natural Sciences, Philadelphia

Important Bird Area Monitoring and Conservation Project

Audubon Pennsylvania

Federal Fiscal Year 2004

Inventories and Status Assessments of Pennsylvania At-Risk Amphibian and Reptile Species

Shippensburg University

Important Mammal Areas Project - Emphasis on Stewardship

National Wildlife Federation and Pennsylvania Wildlife Federation

Freshwater Mussel and Fish Assemblage Habitat Use and Spatial Distribution

Western Pennsylvania Conservancy, Northwest Field Station

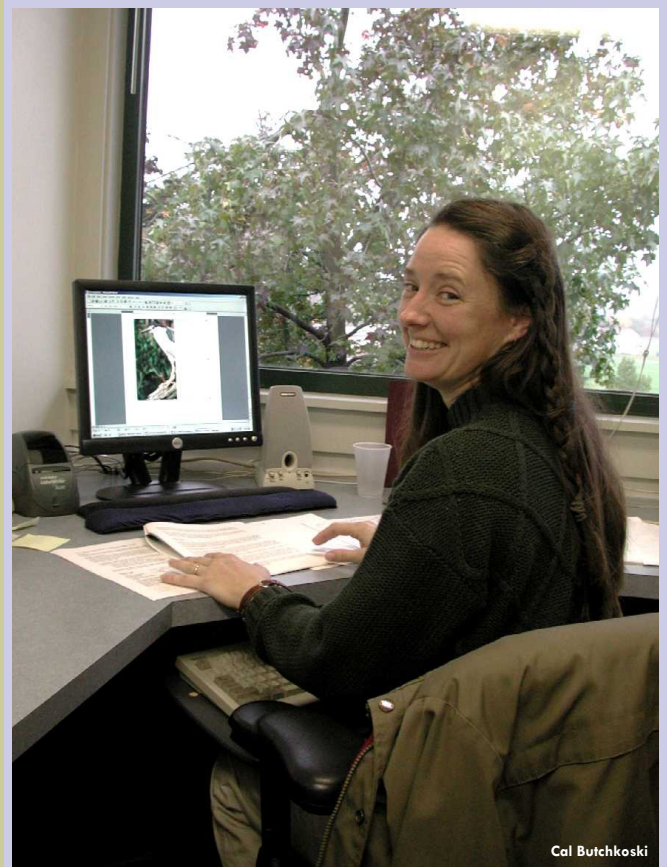
Web-Based Registry and Study of Seasonal Pools in Pennsylvania

Western Pennsylvania Conservancy

Eastern Hemlock and Mixed Coniferous Forested Ecosystems: Distribution and Use by Sciurid Communities

Including the Northern Flying Squirrel

Penn State University



State Wildlife Grant Coordinator Patti Barber expertly guides grant applicants, project cooperators, and WDP staff through red tape.

To read descriptions of the FFY 2003 projects listed at left, as well as those from 2001 and 2002, visit the State Wildlife Grant Program page on the Pennsylvania Game Commission website.

Go to www.pgc.state.pa.us

Select **Wildlife** on the left

Select **State Wildlife Grants** on the right

In the State Wildlife Grants Program box on the right, you can select from a variety of topics. By selecting a year, you will find summary paragraphs about that year's cooperative projects.

Want to read more about it? Click [detailed project overview](#) at the end of the summary paragraph. For some projects there are links to a page on the cooperator's website.

THE FUTURE

As in the past, the Wildlife Diversity Program will actively engage the public, private landowners, and an array of research and management colleagues in the conservation of species of concern.

In addition to efforts described in the preceding pages, Wildlife Diversity Program (WDP) staff will continue to provide technical assistance and expertise during field views and biological assessments for projects - including roads, mines, quarries, gas wells, and wind farms - with potential impact on species of concern. They will also provide educational programs for conservancies, nature centers, state parks. Ongoing regional and national efforts continue to include the U.S. Geological Survey Breeding Bird Survey, Partners in Flight, the Northeast Bat Working Group, and Bat Conservation International workshops.

Formulation of the federally required Comprehensive Wildlife Conservation Strategy (CWCS) has made clear the degree of research, planning, and effort needed to conserve our species of concern. We are fortunate to have a wealth of committed staff, collaborative partners, and conscientious volunteers because new challenges inevitably arise.



With the growth of the wind energy industry has come the realization that giant turbines, especially those placed on wooded ridges, pose a threat to both residential and migratory birds and bats. As one U.S.D.A. Forest Service Endangered Species Specialist put it, "We need to figure out a way to get our arms around this issue before it hits us full force."

Efforts are underway to identify causes and possible solutions to bird and bat fatalities generated by wind turbines. To that end, Greg Turner, Pennsylvania's Endangered Mammal Specialist, attended the November 2004 meeting of the National Wind Coordinating Group in Lansdowne, Virginia.

To date, Pennsylvania has received more than \$9 million in federal State Wildlife Grants (SWG) funding, which has greatly benefited fish and wildlife conservation efforts in the Commonwealth. For the first time in our history, the Game Commission and Fish and Boat Commission are in a position to proactively manage our diverse fish and wildlife resources, including low and declining species. We have used the funds primarily for much-needed information on the population status, distribution and abundance, and threats facing our "non-game" species - some of which, due to a prior lack of funds, have received no directed management attention in the history of our agencies.

The Wildlife Diversity Program will continue to work through the successful three-pronged approach implemented this year:

- Supporting high-priority research through cooperative projects with our academic and conservation partners.
- Providing technical assistance on private lands management through our Regional Wildlife Diversity Biologists.
- Strategic planning through our development of the CWCS.

Made possible by SWG funding, this approach is moving the WDP closer to the goal of endangered species prevention - management at the state level before species require protection under the Federal Endangered Species Act.



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